MODIFICATION OF AN AMBIENT AIR QUALITY MODEL FOR ASSESSMENT OF US NAVAL AVIATION EMITTANTS

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THESIS

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FOR
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by

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June 1975

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Two programs which form part of a generalized air quality assessment model for USAF operations were obtained and analyzed. Areas of incompatibility with USN aircraft operations were identified and modified to closely approximate these operations. Data were obtained by observation of operations at a Naval Air Station and these data used to execute the modified programs. These results and the program modifications are discussed.

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for
Assessment of US Naval Aviation Emittants

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Submitted in partial fulfillment of the
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ABSTRACT

Two programs which form part of a generalized air quality assessment model for USAF operations were obtained and analyzed. Areas of incompatibility with USN aircraft operations were identified and modified to closely approximate these operations. Data were obtained by observation of operations at a Naval Air Station and these data used to execute the modified programs. These results and the program modifications are discussed.

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I. INTRODUCTION

In recent years there has been an increasing awareness within the general public of the environment and its quality. This awareness has manifested itself as conservation oriented advertising, litigation to prevent environmental damage and advocacy of environmental consideration prior to any government or private action. One response of the Federal government to these actions was the establishment of the Environmental Protection Agency (EPA). The areas of interest to this agency cover an extensive gamut including water, land and atmosphere and prevention of pollution thereof by noise, pesticides and other chemicals. One specific area addressed by the EPA was the pollution of the lower atmosphere by combustion products produced by commercial aircraft.

Subsequent to investigation of the problem and consultation with commercial aircraft operators, aircraft and engine manufacturers and the United States Air Force (USAF), the EPA defined several new aircraft operating parameters. Specifically, one defined parameter was an average landing and take off cycle time-in-mode (LTO). The EPA also prescribed the techniques for measuring emissions during a simulated LTO, and established an emissions limit schedule for each engine thrust category based on the engine type and date of manufacture [Ref. 1].

Neither the Clean Air Act, under which EPA issues implementing guidance, nor Executive Order 11752, which gives basic environmental protection guidance to Federal agencies, authorize the EPA, or state or local agencies to set emission standards for most military aircraft and the engines thereof. Nevertheless, in a spirit of cooperation, the United State Navy (USN) investigated whether or not its operations exceeded the new EPA parameters.

The first area of investigation undertaken by the USN was the measurement, in accordance with EPA techniques, of those emissions generated by engines currently in use by the USN. While some measurements of smoke levels had been taken previously with the objective of reducing visibility of aircraft in a combat environment, those measurements were aimed primarily at visible particulate matter emissions. Those emissions limited by the EPA but not readily visible in the atmosphere, such as carbon monoxide (CO), oxides of nitrogen (NO_X) and unburned evaporative hydrocarbons (HC) had not been measured. An ongoing program of measurement of these emissions was established and a catalogue of such measurements is published by the Aircraft Environmental Support Office (AESO), as measurements are performed by various DOD Facilities [Ref. 3].

While these emission levels are essential information to any control program, they must be utilized within the format of the EPA established LTOs. These cycles appear to be valid for commercial air operations; however, military air operations present several different parameters. The original EPA LTO cycles consisted of five

phases: taxi/idle (out), take-off, climb-out (to 3,000 ft. altitude above ground level), approach (from 3,000 ft.) and taxi/idle (in). These cycles have recently been redefined as having ten phases by the EPA [Ref. 4], but merely break the original five into smaller, more extensively defined segments. The applicability of these cycles to military operations is tenuous at best, since they fail to consider such segments of operation as touch-and-go landings and a specific of USN air operations only, the Field Carrier Landing Practice evolution (FCLP). Since these evolutions take place wholly below 3,000 ft. altitude and constitute a large percentage of the total operations at many Naval Air Stations, this omission generates an important question of USN compliance capability.

The EPA has as its goal the prevention of degradation of ambient air quality. Their need is for an accurate quantification of emissions and their distribution throughout a local environment. Once quantification is accomplished, credible control procedures can be instituted by the operating agency/corporation to meet EPA requirements. One obvious approach to the quantification of such data is to establish a grid of receptors at each site of aircraft operations and collect the desired data. The magnitude of the cost of such a program in both money and man-hours makes this approach prohibitive. The current effort of the USAF is to develop a computer program that will calculate emissions based on numbers of operations at a

location coupled with meterological parameters. These results are then to be verified by limited measurements.

To this end Argonne National Laboratory has been contracted by the USAF to develop a computer model based on the well known "Air Quality Display Model" (AQDM) to estimate the concentrations of pollutants through-out a theoretical grid of receptors over a period of time. Under this contract Argonne has developed a preliminary version of "A Generalized Air Quality Assessment Model for Air Force Operations" (AQAM), which brings together several models of different pollution sources and will serve as a device for assessing environmental air quality [Ref. 5]. Final evaluation of the accuracy of this package is awaiting actual measurement of operations at an air base.

Argonne's original contract included 12 specific tasks [Ref. 5]. Among them was a generalization and update modification of AQDM to obtain long-term average calculations which included aircraft landings and take-offs as a source of emissions. In addition they were to develop a short-term model which performed hourly calculations and an inventory model which summarized annual emissions at an activity by source.

Liason between the Air Force Weapons Laboratory at Kirtland AFB, New Mexico, the Naval Air Propulsion Test Center (NAPTC) at Trenton, New Jersey, and the Naval Postgraduate School, Monterey, California created USN

interest in the Argonne model. Accordingly a copy of both the Source Inventory and Short-term pollution models were obtained for evaluation and possible adaptation to USN operations.

The purpose of this study was to begin adaptation of the short-term AQAM model to Navy operations, and to use the modified model to perform an initial evaluation of the effect of air operations at the Miramar Naval Air Station on ambient air quality.

II. MODEL OVERVIEW

AQAM consists of four separate "packages": a Source Inventory Program, a Meteorological Data Program, a Short-term Emission Dispersion Program and a Long-term Emission Dispersion Program [Ref. 5]. The relationship of the programs is shown in Figure 1. The Meteorological Data Program is used only as input to the Long-term model and therefore will not be discussed herein. The Long-term model differs from the Short-term model in that it is a climatological-dispersion model using annual stability-wind-roses. It utilizes somewhat different dispersion equations and computes the annual average of hourly average concentrations. The area of interest will be restricted to the Source Inventory Program and the Short-term model.

The Source Inventory Program computes the annual emissions of three groups of sources: aircraft, air-base but non aircraft, and environment (off air-base). Each of these groups is further broken down by its geometric configuration into point sources, area sources and line sources. This initial study will consider only aircraft emission sources.

The Source Inventory Program is used to calculate the emissions from aircraft operations and associated activities. To calculate their emissions requires specific operational data. For example, specification

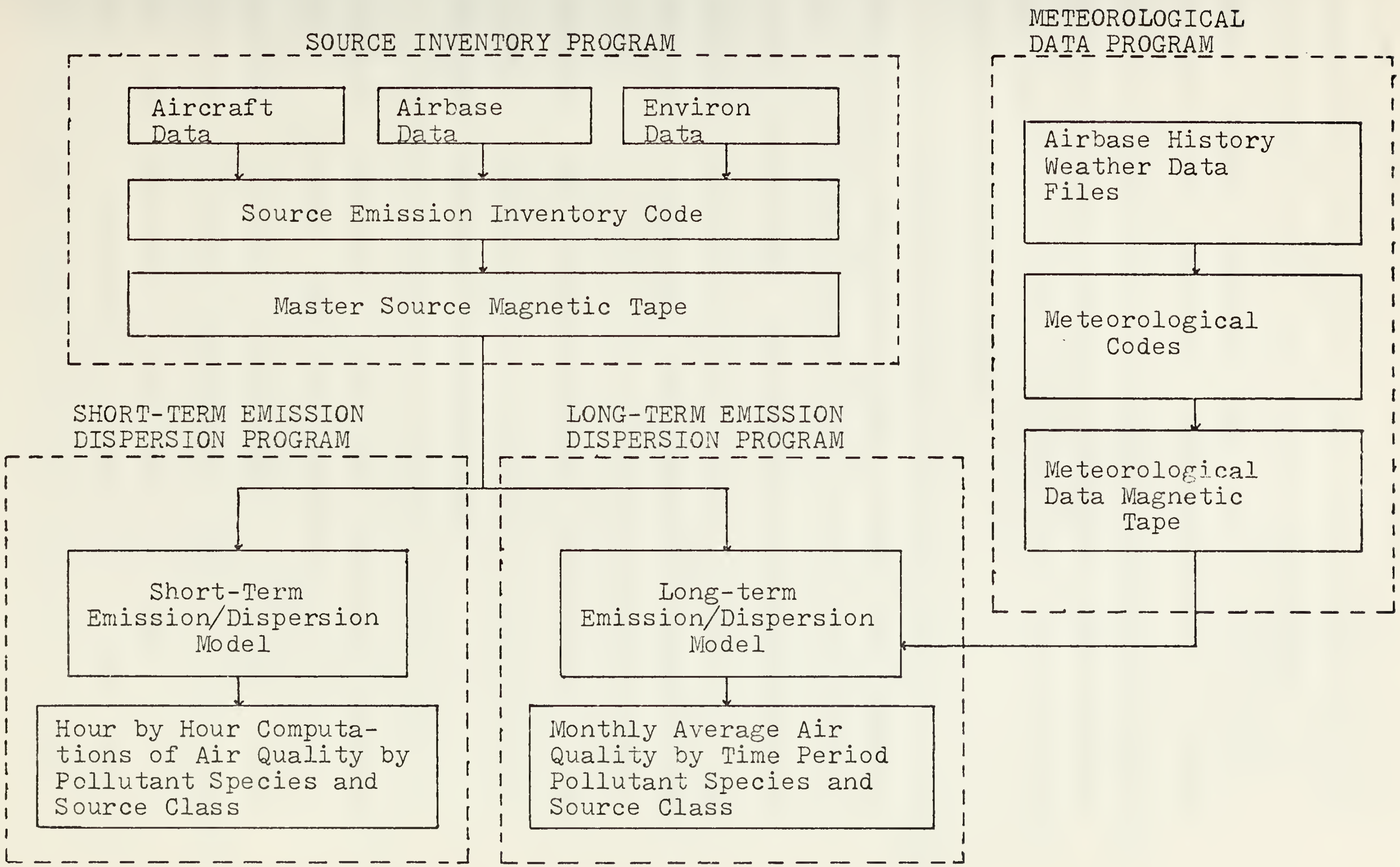


FIGURE 1. RELATIONSHIP OF PROGRAMS OF THE AIR QUALITY ASSESSMENT MODEL [Ref. 5].

of the take-off of an aircraft requires the x, y, and z coordinates of the aircraft tail pipe at the beginning of its take-off roll, the aircraft gross weight, its take-off speed, its engine type, whether afterburner equipped, engine emissions in four modes, etc. It then treats this take-off as an uniform acceleration along the appropriate runway vector for the given wind direction, and calculates the total emissions generated during this activity by pollutant type.

In an analogous fashion the program computes emissions from aircraft during two climbout modes, two approach modes, a landing roll-out mode and two taxi modes (departure and arrival). In addition it accepts data on emissions of ground service vehicles during arrival and departure and calculates the evaporative unburned hydrocarbons emitted from vapor discharge during aircraft refueling. The latter calculation is based on the vapor volume of a partially full aircraft fuel tank, another data input dependent on aircraft type.

The Source Inventory Program is thus by itself an extremely comprehensive model for calculation of emissions. The two parameters used for calculations are emission rates per operating mode and time in this mode. Since the former of these parameters is based on actual measurement while the latter is calculated by simple geometry, the resultant amounts can be expected to closely approximate the actual amounts. The one weak point of this

program is the voluminous amount of accurate data inputs required. The data for this study, restricted to aircraft inputs for one Naval Air Station (NAS) only, constitute over 80 man-hours for data collection and analysis of previously collected data.

The AQAM Short-term Program, hereafter referred to as AQAM, receives the compiled annual results of the Source Inventory Program and calculates the dispersion of generated pollutants during a given hour, day and month utilizing average meteorological conditions for that hour. For point and area sources this is accomplished by using initial source dimensions and meteorological stability criteria to project a pseudo upwind point source and then treating the dispersion of pollutants as emanating from this psuedo source. For line sources, AQAM utilizes a dispersion theory developed by Argonne based on a Puff Model. In short, it treats a linear source as a line of uniformly dense "puffs" generated along the route of travel and then calculates the dispersion of each "puff" in the aforementioned meteorological conditions. Most of this treatment is thus based on Gaussian dispersion theories and as such still requires verification by measurement.

III. ADAPTATION REQUIREMENTS

While Argonne performed extensive development within their contract, their results still contain a limitation of the EPA's LTO cycles. This limitation is that all operations in their program occur in one vertical plane. While this is an accurate typification of both commercial and military aircraft operations during inclement weather, military operations deviate from this idealization frequently. This occurs during atmospheric conditions which allow a pilot visual reference of the ground and other aircraft. A pilot flying solely by reference to cockpit instruments is flying by a set of procedures denoted as Instrument Flight Rules (IFR). Conversely, when a pilot can maintain a visual attitude reference and maintain safe separation of his aircraft from others by his own vision, he is allowed to follow a set of procedures denoted as Visual Flight Rules (VFR). Figure 2 depicts a typical commercial or military IFR approach and departure. Figure 3 depicts typical military operations under VFR conditions.

Not only does military aviation differ from commercial aviation in the landing and departure evolutions, but US Naval Aviation procedures differ from USAF procedures as well. This is caused by the dissimilar operational landing facilities used by the two services. A USAF aircraft always utilizes a runway or other prepared surface for

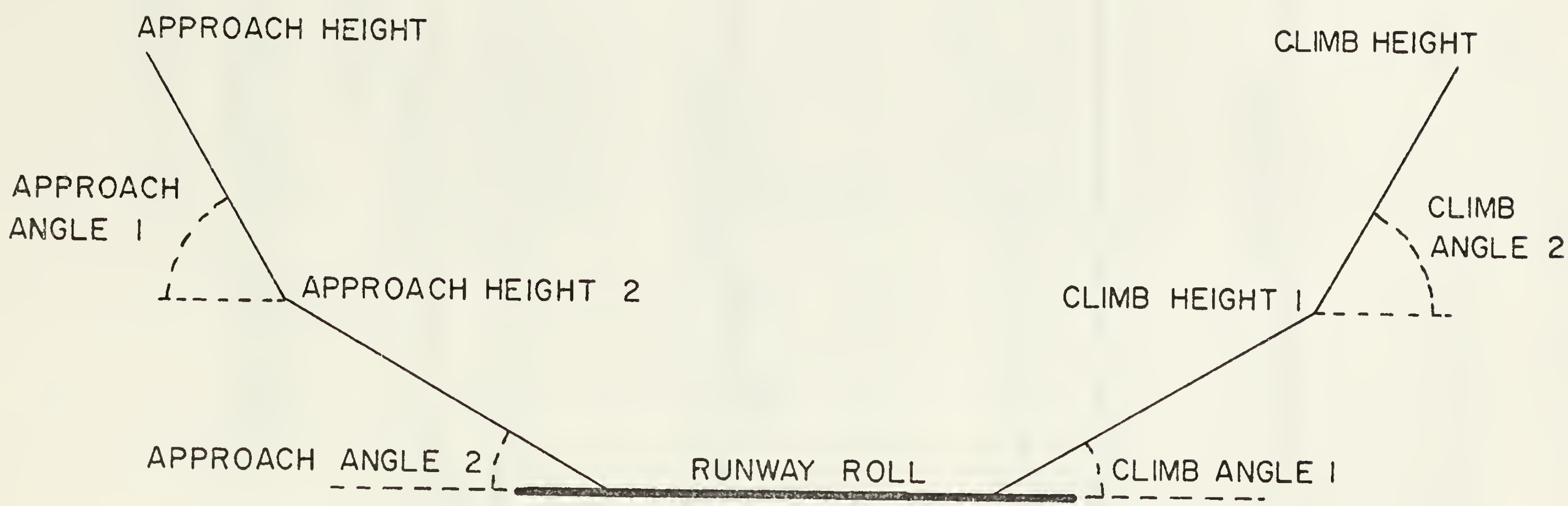
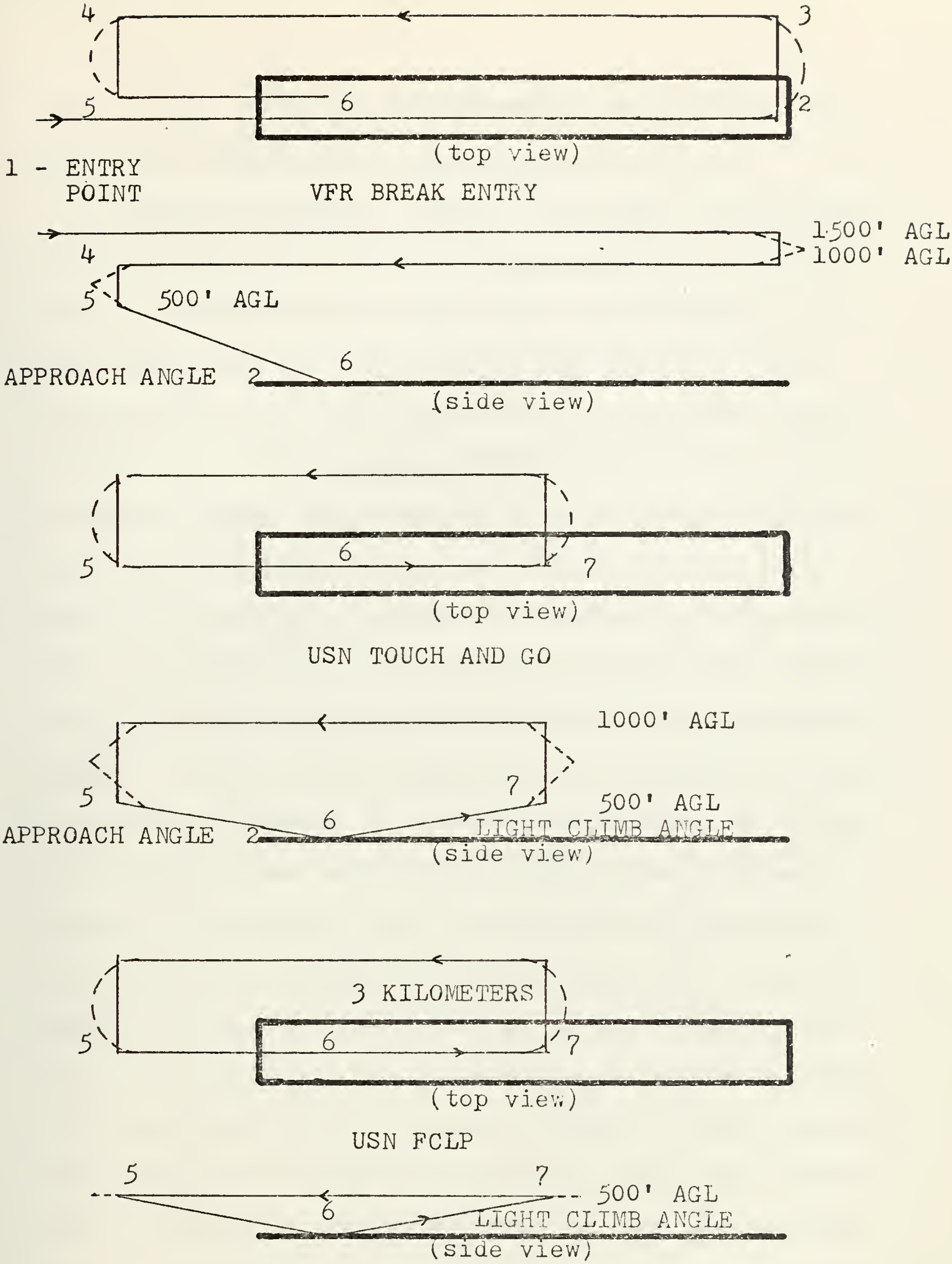


FIGURE 2. IFR APPROACH AND DEPARTURE



VFR TRAFFIC PATTERNS
FIGURE 3

take-offs and landings, as opposed to Naval Aviation's use of the comparatively small aircraft carrier.

Briefly expanding on these operational differences, a USAF touch-and-go can be characterized as a downwind leg flown at an airspeed well above stall speed, a descending crosswind leg at this same speed, a final approach leg at a slower speed (still well above stall), a flare to a "soft" landing within the first one quarter of runway length, an accelerating roll of approximately 1,000 feet, a liftoff and climb (once more at a safe speed), and finally a climbing crosswind leg at this same speed. In contrast, a USN carrier type aircraft performs a touch-and-go as practice for landing aboard an aircraft carrier. Since kinetic energy must be expended by arrestment aboard a carrier it is held to a minimum by flying the aforementioned pattern at a much slower airspeed. Because the touchdown area on a carrier for successful arresting gear engagement is relatively small the final approach segment is flown down a precise optical glide path at a constant rate of descent to a touchdown within a 50 foot length with no flare. Finally, since successful arrestments don't always accur, the carrier type aircraft adds full power at touchdown, gaining safe flying speed almost instantaneously and performing the initial climb segment of the aforementioned pattern with little ground roll. A USN FCLP pattern is similar to a touch-and-go pattern except that both the crosswind legs and the

downwind leg are flown at an altitude of 500 feet above ground level versus a typical 1,000-1,500 feet for touch-and-go landings. Since over half the operations at a carrier type aircraft NAS consist of FCLPs and touch-and-go landings their inclusion in both the Source Inventory Program and AQAM was necessary.

Another vagary of USN carrier aviation is a method of refueling aircraft with their engines running, termed "hot refueling." Naval carrier aircraft are designed to safely pressure refuel on aircraft power while aboard an aircraft carrier to reduce both "turnaround time" (the time between an aircraft landing and being ready to take-off once more) and the numbers of personnel and equipment on the flight deck during this evolution. Advantage is taken of this capability at most carrier type aircraft home fields for similar reasons. Both the Source Inventory Program and AQAM are based on aircraft refueling, after shut down in a parking area, from fuel trucks.

IV. ADAPTATIONS ACCOMPLISHED

The initial modification undertaken was to input the crosswind and downwind aircraft paths described in the previous section into the Source Inventory Program. To approximate the actual flight paths of an aircraft some simplifying assumptions were made and some data inputs added. The points referenced in the following descriptions are depicted in Figure 3.

Data collection revealed that during daytime visual flight meteorological conditions (VFR) over half the approaches to an NAS were made from an initial entry point (point 1) five to eight miles from the NAS. These entries are made at a high speed, typically 325 knots maximum, and are made so as to arrive over the approach end of the runway in use at a "break" altitude, typically 2,000 feet above ground level. The aircraft then proceeds at this altitude along the runway heading until it reaches the "break" point (point 2). This point is determined either by the need of the aircraft for sufficient distance between itself and any preceding aircraft to give a safe interval of time between their respective landings, or until it has traveled approximately one-half the runway length, whichever occurs later. It then performs a "break" turn (a high angle of bank turn) in the direction of the traffic pattern for the runway in use. This turn

is performed at an idle power setting with a slight descent to pattern altitude and a deceleration to about 150 knots airspeed. At the end of this maneuver the aircraft is in the "dirty" configuration (landing gear and flaps extended), heading parallel to and in the opposite direction of the runway and offset from it by approximately three kilometers (point 3).

To simulate the VFR entry maneuver in a compatible straight line segment form for both the Source Inventory Program and for AQAM, three segments were used and five data inputs added. The first data input added was the distance from the runway that an aircraft reaches 3,000 feet altitude (point 1). During the NAS survey, observations of traffic control radar incorporating automatic altitude readouts revealed this distance to be approximately five miles. The second added data input was that of the break altitude, specified at each NAS by its Operations Manual (1500 feet for NAS Miramar). Each approach of this type was programmed to "break" left or right in accordance with the third data input, the traffic pattern direction. This "break" was programmed to occur after the aircraft had proceeded the length of the runway. This point is farther down the runway than the normal break previously described. Adding length to this approach line compensates for the decreased length of the subsequent curved crosswind turn when it is simulated by a straight line. This elongation also compensates for those aircraft which

"break" beyond the mid-runway point while adjusting their landing interval. Thus, the first line segment was a descending segment from the initial 3,000 foot altitude point to the break point. The second line segment added was a descending one, normal to the first, descending from the "break" point to a point three kilometers from it at a pattern altitude (point 3). This pattern altitude was added as the fourth data input (1,000 feet for NAS Miramar).

The "known" portion of a USN carrier aircraft landing is its final approach. Its landing point (point 6) is pre-determined for all three USN VFR operations described by an optical glide slope device. This device indicates the aircraft's angle of descent and is usually set at three degrees above horizontal. In addition the standard altitude at which the pilot visually acquires the indications of this device is 500 feet, giving another point of the landing pattern (point 5). This point is also common to the three USN VFR operations, and was the fifth data input added to the Source Inventory Program.

Finally, the fourth and fifth traffic pattern segments were simulated by locating a point (point 4) at a distance of three kilometers from the commencing point (point 5) of the final approach simulation line. The segments were then formed by connecting these two points and by connecting the former point to the end of the second (crosswind) segment. While this approximation

extends the third or downwind segment slightly beyond its actual length, it also compensates for the artificial shortening of another descending turn, the turn to final approach, by the fourth straight line segment. (See Figure 3.)

Simulation of FCLPs and touch-and- go landings was accomplished using the same added data inputs. However, this simulation proceeded from the known touchdown point as an ascending straight line to 500 feet of altitude on the runway heading. At this point (point 7) a climbing turn in the appropriate traffic pattern direction was simulated in the same manner as described for the VFR "break" point. Actually this turn is sometimes commenced at a lower altitude, but as in the "break" point discussion, both minimum altitude and the need for a safe interval between aircraft comprise a pilot's criteria for turning. As with the "break" point determination, the selected location of this turning point compensates for both any delay in turning caused by the need for a safe interval and the shortening of the following line segment in comparision with the actual climbing turn. The remainder of the incorporated flight path modifications and adaptations are of a similar nature. All of them are represented in Figure 3.

All aircraft associated parameters which are input data to the Source Inventory Program, such as climb angles, airspeeds and gross weights, were extracted

from the performance charts of the appropriate Naval Air Training and Operating Procedures Standardization Program (NATOPS) Flight Manuals. These parameters are tabulated as Table II.

Once these modifications were made in the Source Inventory Program some compatibility modifications were then necessary in AQAM. One meteorological input to AQAM is the mixing depth. This is a parameter developed by the USAF Environmental Technical Applications Center for Argonne's model which indicates the presence or absence of an inversion layer above the airfield and the relative stability of the atmospheric air mass at the field. All pollutants emitted above this depth are ignored as never reaching the ground in the local area and all line sources penetrating this level are programmed to cease there. Level lines at or above this level were unacceptable to AQAM until it was modified to accept them as null sources.

Another extensive AQAM modification was engendered by its logic of flight operations. Using taxi-way routes from a runway as its basis, AQAM could not calculate any operations on a runway which lacked them. It effectively precluded the use of a runway for only touch-and-go landings, FCLPs or emergency landings to a stop. This problem was circumvented by modifying AQAM to search through all possible operations on a runway for calculations.

A modification of AQAM to accept "hot refueling" was especially desired since this evolution is an easily

varied parameter for pollution control at air stations. AQAM was expanded to accept up to eight additional area sources in order to accept as many "hot refueling" areas.

As developed, AQAM allowed only twenty-five total line segments for the approximation of taxi routes. This number was prohibitively restrictive to the simulation of actual taxi routes and so was doubled.

The most formidable barrier to the modification of both programs was the form in which they were received. While developed on an IBM 370 computer by Argonne, part of their contract was for adapting it to use on a Control Data Corporation (CDC) computer. It was the CDC oriented program which was modified for use on the Naval Postgraduate School's IBM 360 computer. Due to the smaller core storage memory of the CDC computer, Argonne followed a routine of "overlaying" their individual programs. "Overlaying" consists of splitting a program into a "root" segment, which is always present in the main storage area, and several branch segments which are overlayed on the "root" segment as needed. The one requirement for each branch segment is that it not require any part of any other branch segment to operate. While this procedure does save core storage required (a reduction from 350,000 bytes to 242,000 bytes for AQAM after modification) it is accomplished in an entirely different manner by CDC than by IBM. On a CDC computer, "overlay" structure is controlled by the FORTRAN language within the program.

IBM, however, constructs and controls "overlays" with machine language external to the actual program, termed Job Control Language (JCL). Since this JCL varies among individual IBM installations, the actual "overlay" Structure for this was formulated at the Naval Postgraduate School IBM Facility using the CDC language as a guide.

No effort was made to evaluate or modify any of the extensive non-aircraft areas of the Source Inventory Program or AQAM. These include civilian and military vehicles, aircraft engine test cells, fuel storage "tank farm" operations, heating of base working spaces and areas for the input of practically all possible environmental pollution sources of a military base. In addition, no attempt was made to quantify emissions of gas turbine powered units used to start jet aircraft, since such data were not easily collected within the time available.

V. DATA ACQUISITION

NAS Miramar, California was selected as the site for data collection for this initial study. This selection was made using four criteria: (1) high annual amounts of operations, (2) a limited variety but large numbers of aircraft carrier type aircraft, (3) only three runways with easily geometrically simulated taxi routes, and (4) the presence of the San Diego air traffic control facility with its extensive and modern radar capabilities. Pre-collected data that were available and utilized herein consisted of a twenty-five year history of meteorological data including winds, cloud cover and temperatures statistically analyzed, a one-year history of field operations classified by month and by type of operation and a six-month history of operations not fully analyzed but used to determine days of maximum and minimum operations. This latter analysis was used to determine all operations by aircraft type except for touch-and-go landings during three days of this six-month period. Data collected during over eighty hours of observations consisted of 23 starts and taxis outbound, 24 taxis-in and shutdown, 40 departures, 35 arrivals and 134 touch-and-go landings. All of these evolutions were timed to within the nearest one-hundredth of a minute. These observations encompassed weather varying from clear, calm wind, and daytime to

heavy rain and hail, strong winds and nighttime. They represent both days of typically few operations and days with extremely large numbers of operations. The observation points utilized were the "line" (aircraft parking) areas for starts, taxis and shutdowns, the radar facility for approaches and departures and the control tower for touch-and-go landings and non-timed traffic pattern evolutions. Summaries of these data are presented as Tables I-III, the data sheet utilized for data collection is presented as Figure 4 and a geographic plot of NAS Miramar is presented as Figure 5.

TABLE I

COLLECTED DATA

NAS MIRAMAR, CA. 10-14 MARCH 1975 and 5-8 MAY 1975

A. DEPARTING AIRCRAFT
(ELAPSED TIME IN MINUTES)

AIRCRAFT TYPE	PARKING AREA	START	TAXI[1]	TAKEOFF	ENGINE CHECK
F-4	A	1.99	14.15	.82	.2
	A	1.83	23.42	.72	.2
	A	2.21	16.35	.83	.2
	C	1.60	14.68	.79	.2
	D	3.57	30.79	.88	.2
	D	1.39	34.89	.98	.2
RF-8G	D	.35	13.18	.71	NONE
F-8J	E	.20	20.08	.92	NONE
	E	.10	19.84	.92	NONE
F-14	C	2.19	38.13	.82	NONE
	C	2.62	26.01	.77	NONE
	C	2.25	29.21	.76	NONE
	C	2.15	33.37	.79	NONE
A-4	C	.17	17.87	.51	NONE
	C	.30	15.92	.91	NONE
	C	.29	30.94	.95	NONE
	C	.28	34.14	.89	NONE
F-5	D	1.02	12.47	.75	NONE
	D	1.16	10.19	.72	NONE

1. Includes pre-taxi checks performed in parking area.

TABLE I (CONTINUED)

B. ARRIVING AIRCRAFT
(ELAPSED TIME IN MINUTES)

AIRCRAFT TYPE	PARKING AREA	HOT REFUEL	TAXI	SHUTDOWN
F-4	D	8.72	11.68	4.78
	D	8.75	13.10	5.02
	E	9.79	12.44	5.01
	E	NONE	14.84	5.07
	C	NONE	8.11	5.13
	A	8.58	13.56	5.09
	A	8.12	13.29	5.14
	D	7.47	19.74	5.01
	D	10.21	14.12	4.98
	D	NONE	5.85	4.75
	D	9.91	8.20	4.86
RF-8G	D	NONE	8.20	4.97
F-8J	E	NONE	8.04	5.10
	E	7.74	13.46	4.68
F-14	C	NONE	8.11	9.38
	C	9.20	11.84	10.01
	C	13.50	13.70	9.96
	C	23.41	5.53	11.06
A-4	C	NONE	9.40	4.64
	C	NONE	9.31	5.01
F-5	D	NONE	6.23	4.98
	D	NONE	8.28	5.11
C-9	B	NONE	4.00	2.03

TABLE II

DATA FROM NATOPS MANUALS

AIRCRAFT	PARAMETER					
	APPROACH SPD (KNOTS)	CLIMB ANGLE (DEGREES)	CLIMB SPD (KNOTS)	LAND SPD (KNOTS)	TAKEOFF SPD (KNOTS)	LIGHT CLIMB ANGLE (DEGREES)
F-4J[1]	137.5	3.58/3.86	400/400	137.5	174	4.08
RF-8G[2]	141	2.54/12.9	350/400	141	152.5	2.86
F-8J[3]	126	2.58/12.9	350/400	126	152.5	2.86
F-14[4]	125	5.0/13.0	400/400	125	125	6.7
A-4[5]	130	2.38/9.9	304/304	130	148.5	2.58

1. NATOPS FLIGHT MANUAL, F-4J AIRCRAFT, NAVAIR 01-245FDD-1 of 15 JAN 1970
2. NATOPS FLIGHT MANUAL, RF-8A/RF-8G AIRCRAFT, NAVAIR 01-45HHB-501 of 1 JULY 1973
3. NATOPS FLIGHT MANUAL, F-8J AIRCRAFT, NAVAIR 01-45HHF-1 of 15 DEC 1969
4. NATOPS FLIGHT MANUAL, F-14A AIRCRAFT, NAVAIR 01-F14AAA-1 of 1 JUNE 1974
5. NATOPS FLIGHT MANUAL, A-4E/F AIRCRAFT, NAVAIR 01-40AVC-1 of 15 JUNE 1969

TABLE III

DATA INPUT TO SOURCE INVENTORY

A. AIRCRAFT DATA

NAME	ENGINE NAME	AFTERBURNER	NUMBER ENGINES	DESCENT ANGLE 1/2 (DEGREES)	APPROACH SPEED 1/2 (KM / HR)
F-4	J79-G10	YES	2	3.0 / 3.0	254.7 / 254.7
RF-8G	J57-P16	YES	1	3.0 / 3.0	261.3 / 261.3
F-8J	J57-P420	YES	1	3.0 / 3.0	233.5 / 233.5
F-14	TF30-P408	YES	2	3.0 / 3.0	222.3 / 222.3
A-4	J52-P8	NO	1	3.0 / 3.0	240.9 / 240.9
TRANSIENT	J52-P8	NO	2	* / *	* / *

NAME	CLIMB ANGLE 1/2 (DEGREES)	CLIMB SPEED 1/2 (KM/HR)	LIGHT CLIMB ANGLE (DEGREES)	CLIMB HEIGHT (KM)	TAXI SPEED (KM/HR)
F-4	3.58 / *	* / *	4.08	.1524	6.97
RF-8G	2.58 / 12.9	554 / 554	2.86	.1524	8.02
F-8J	2.58 / 12.9	554 / 554	2.86	.1524	8.02
F-14	5.00 / 13.00	554 / 554	6.70	.1524	6.45
A-4	2.38 / 9.90	554 / 554	2.58	.1524	11.13
TRANSIENT	* / *	* / *	*	*	*

* Indicates appropriate default values present in modle, and used without change.

TABLE III (CONTINUED)

NAME	LAND SPEED (KM / HR)	TAKE OFF SPEED (KM / HR)	SHUT DOWN TIME (MINUTES)	TAKE OFF WEIGHT (1000 POUNDS)	RUNWAY ROLL EQUATION ***
F-4	254.7	322.4	5.0	*	*
RF-8G	261.3	282.6	5.0	29.0	11
F-8J	233.5	282.6	5.0	31.0	11
F-14	222.3	231.6	10.0	40.0	12
A-4	240.9	275.2	5.0	22.5	16
TRANSIENT	*	*	*	*	20

* Indicates appropriate default values present in model and used without change.

*** Refers to an equation within the model which is used to simulate the take off of an aircraft. This equation determines runway roll distance based on aircraft type, weight and take off speed and airbase wind, elevation and temperature.

TABLE III (CONTINUED)

B. ENGINE DATA

(Table numbers refer to AESO Technical Report 101-Revision) of June 1974, "Aircraft Engine Emissions Catalog."

ENGINE NAME	TABLE NUMBER
J79-G10	II-71 C
J57-P16	II-47 C
J57-P420	II-48 D
TF30-P408*	II-89 A
J52-P8	II-33 A

* Afterburner data from AFWL TR-74-303, Dec. 1974, P. 12.

C. ACTIVITY DATA

(Percent of Total Activity)

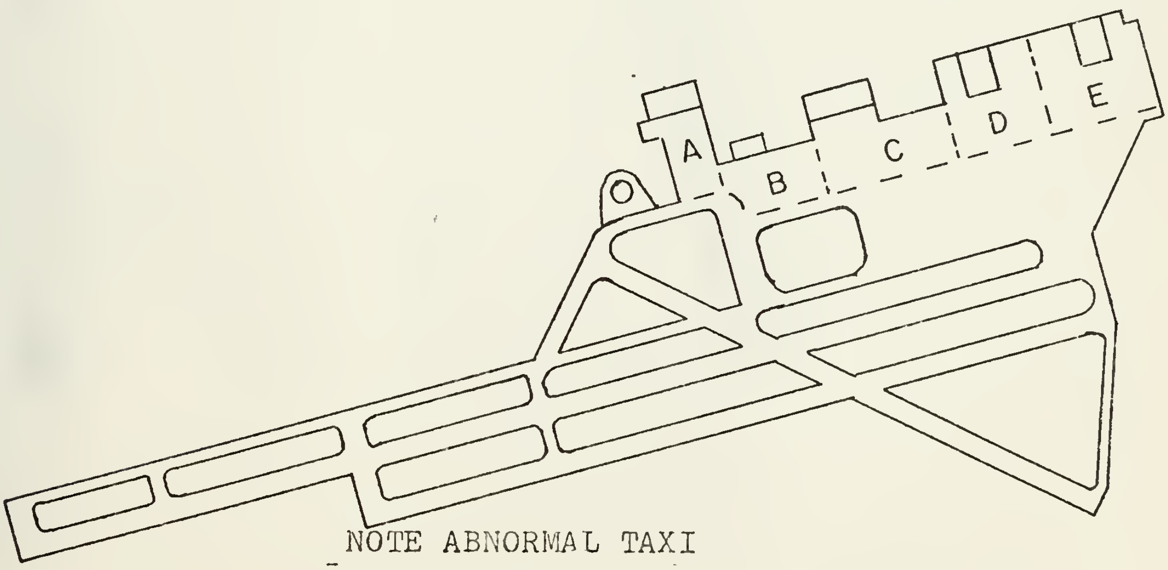
Month	%	Hour	%	Hour	%	Day	%
Jan	9.6	1	0	13	8.2	Weekday	18.0
Feb	6.2	2	0	14	8.2	Weekend	5.0
Mar	8.5	3	0	15	8.2		
Apr	11.2	4	0	16	8.2		
May	8.5	5	0	17	6.0		
Jun	7.2	6	0	18	6.0		
Jly	7.6	7	6.8	19	6.6		
Aug	6.6	8	6.8	20	2.2		
Sep	6.6	9	8.2	21	0		
Oct	8.7	10	8.2	22	0		
Nov	10.6	11	8.2	23	0		
Dec	6.5	12	8.2	24	0		

TAXI DATA SHEET

LANDING RWY LOCAL TIME TAKEOFF RWY

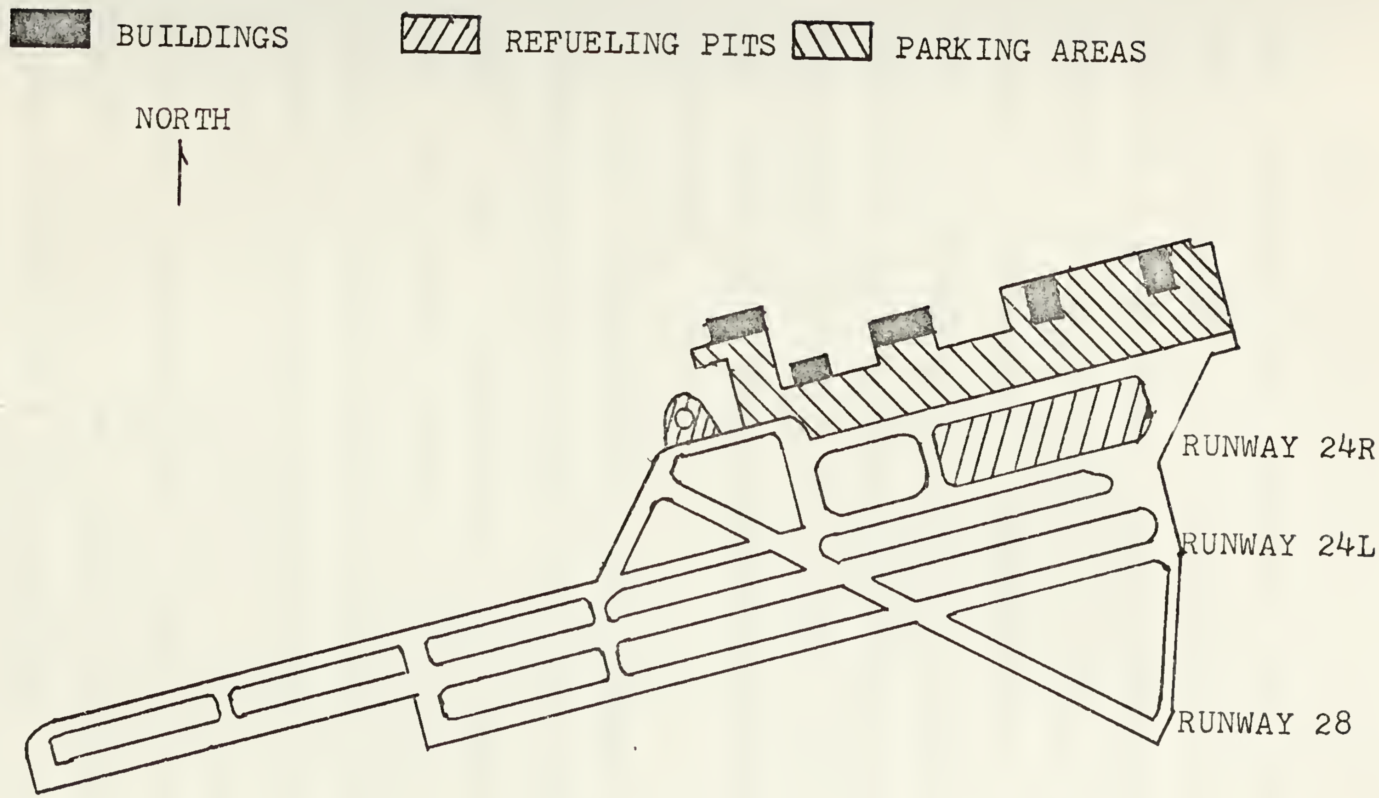
1	Register/Time	2	Register/Time
Side Number	/	Side Number	
Line Area		Line Area	
Commence	0 / 0	Commence	/
Start Complete	/	Start Complete	/
Taxi Complete	/	Taxi Complete	/
Engine Check	/	Engine Check	/
Takeoff Comm.	/	Takeoff Comm.	/
Takeoff Compl.	/	Takeoff Compl.	/
Landing Compl.	/	Landing Compl.	/
Clear Runway	/	Clear Runway	/
Pits	/	Pits	/
Refuel Compl.	/	Refuel Compl.	/
Shutdown	/	Shutdown	/

4	Register/Time	3	Register/Time
Side Number		Side Number	
Line Area		Line Area	
Commence	/	Commence	/
Start Complete	/	Start Complete	/
Taxi Complete	/	Taxi Complete	/
Engine Check	/	Engine Check	/
Takeoff Comm.	/	Takeoff Comm.	/
Takeoff Compl.	/	Takeoff Compl.	/
Landing Compl.	/	Landing Compl.	/
Pits	/	Pits	/
Refuel Compl.	/	Refuel Compl.	/
Shutdown	/	Shutdown	/



NOTE ABNORMAL TAXI

DATA COLLECTION SHEET
FIGURE 4



NAS MIRAMAR, CALIFORNIA

FIGURE 5

VI. RESULTS AND DISCUSSION

Prior to receipt of the Source Inventory Program and AQAM, both had been evaluated by the Air Force Weapons Laboratory (AFWL). This evaluation took the form of data collection at Williams Air Force Base [Ref. 5] followed by execution of the two models utilizing this data. Verification of the accurate reconstruction of the programs at the Naval Postgraduate School consisted of obtaining a duplicate data card deck of Williams Air Force Base from the AFWL and executing the Source Inventory Program and AQAM with them. These results were identical with those of the AFWL.

After modification of the programs was accomplished, the Williams Air Force Base data were once more used to execute them. Comparison of the outputs from the pre- and post- modification versions of the Source Inventory Program revealed identical results for those aircraft which did not make touch-and-go landings except for a slight increase in landing roll-out emissions. This increase was expected since the touchdown point of normal landings had been modified to be 500 feet closer to the approach end of the runway to approximate USN touchdowns. For those aircraft which performed touch-and-go landings the expected increase in total emissions from the addition of a downwind leg was verified. The dispersion concentrations decreased,

however, due to the replacement of the landing roll-out line by a downwind leg in the touch-and-go landing cycle. This decrease was expected since the mixing depth given for Williams Air Force Base was below the height of the added downwind leg, while the landing roll-out line had been below this depth.

Once verified, the Source Inventory Program and AQAM were executed using the data from NAS Miramar. The Source Inventory Program was run simulating two different conditions: hot refueling and parking area refueling. Comparative tabulation of selected results of these runs is presented as Table IV, and complete computer outputs are presented in Appendix A. All of the outputs which constitute the results of this study are available at the Department of Aeronautics, Naval Postgraduate School.

While Figure 1 depicts the relationship between the Source Inventory Program and AQAM, it doesn't describe the information which AQAM receives. The Source Inventory Program actually performs two separate calculations. The first calculation consists of reading data inputs and computing the location, geometry and rates of emissions of all the input sources. This information is then sent to AQAM. The second calculation performed consists of multiplying these source emission rates by the annual number of hours that they are producing emittants and totaling the result by source and pollutant type. These totals are then printed as the annual pollutant inventory of the surveyed activity.

TABLE IV

TABLE OF ANNUAL EMISSIONS
NAS MIRAMAR, CA.

CALCULATED from OPERATIONS

OCCURRING 1 MARCH 1974 - 28 FEBRUARY 1975

Aircraft	With Hot Refueling			Without Hot Refueling		
	Pollutants in Metric Tons x 10^{-3}					
	CO	HC	NOx	CO	HC	NOx
F-4	1154	239.5	396.6	960.3	199.7	384.5
RF-8G	114.1	84.2	36.1	99.4	69.8	35.5
F-8J	216.2	166.4	100.5	179.3	134.8	99.5
F-14	328.0	138.0	135.1	266.3	105.6	127.9
A-4*	100.2	81.4	27.4	100.2	81.4	27.4
F-5*	.101	.03	.01	.101	.03	.01
Transient*	45.44	37.1	19.7	45.4	37.1	19.7
Total	1958	746.7	711.8	1651	628.4	694.4

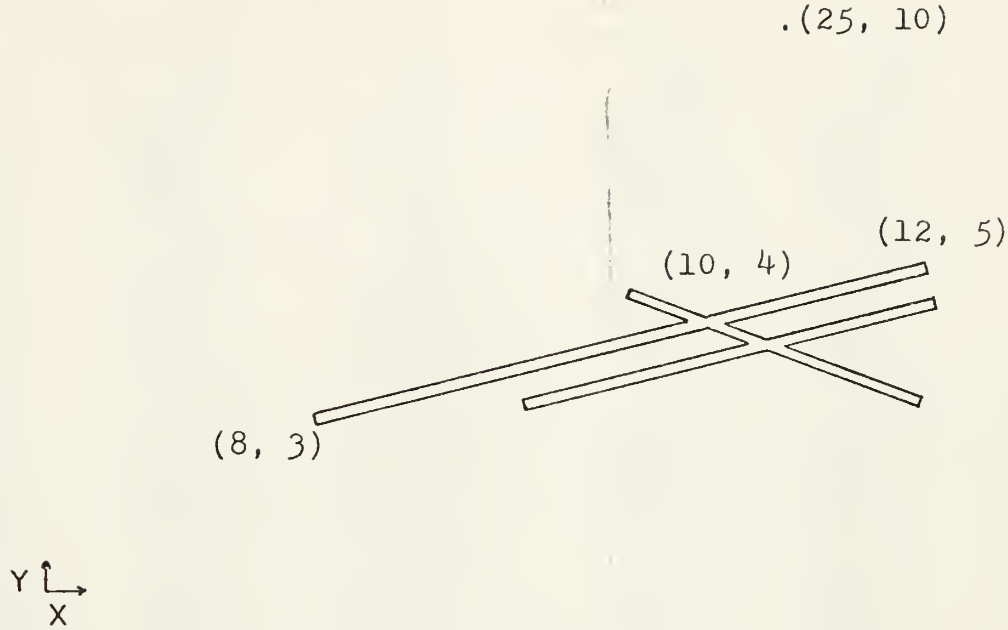
* Normally do not hot refuel at NAS Miramar.

The second calculation performed by the Source Inventory Program is independent of the geometric location of any source and provides no information to AQAM. This fact allowed the modification of AQAM without a corresponding compatibility modification of the Source Inventory Program for the hot refueling comparison. First the Source Inventory Program was executed with no hot refueling data inputs. AQAM was then executed using the required Source Inventory output. After modification to internally generate hot refueling emittants, AQAM was once again executed. Finally the hot refueling emittants were simulated for the Source Inventory Program by adding a data input of ten minutes idle time to each hot refueling aircraft. The Source Inventory Program was then executed to compute the annual amount of emittants produced with hot refueling being practiced.

It was found that this parametric change resulted in an 18 percent increase in annual CO emissions and evaporative HC emissions and a negligible increase in annual NO_x emissions. These increases include the pollutant reduction achieved by not having a fuel truck operate for 15 minutes in the appropriate parking area for each aircraft arrival.

The modified AQAM model was run with the NAS Miramar data for four specific cases: 1200 to 1300 and 1900 to 2000 on 7 May 1975 with four aircraft hot refueling, and the same two periods with no hot refueling. Comparative tabulation of selected results of these run is presented as Table V.

TABLE V



RECEPTOR CONCENTRATION PREDICTIONS
OF POLLUTANTS FROM AIRCRAFT SOURCES
(ARITHMETIC MEAN)

PERIOD: 1200-1300 WEEKDAY MAY 1975
WINDS: 200 DEGREES AT 2.57 METERS/SEC.
TEMPERATURE: 65 DEGREES F.

RECEPTOR		POLLUTANTS (MICROGRAMS / CUBIC METER) $\times 10^{-3}$			
X	Y	CO	HC	NOX	PM
9	4	47.6	15.5	3.4	.72
9	6	3.6	1.3	.69	.15
9	8	1.3	.48	.54	.10
9	10	1.1	.40	.43	.08
10	4	18.2	7.2	3.1	1.1
10	6	7.7	2.7	1.2	.34
10	8	3.6	1.3	1.2	.22
10	10	3.3	1.2	1.6	.35
11	4	4.5	1.8	22.4	1.9
11	6	38.4	13.4	25.5	6.6
11	8	13.4	4.6	10.9	2.6
11	10	9.4	3.2	9.0	2.1

TABLE V (CONTINUED)

X	Y	CO	HC	NOX	PM
12	2	.52	.16	1.5	.39
12	4	.31	.10	.85	.26
12	5	562.1	205.8	759.0	170.9
12	6	150.4	52.7	251.0	58.7
12	8	38.6	13.1	58.8	13.8
12	10	23.7	8.0	34.4	8.0
13	4	.38	.01	.83	.25
13	5	188.9	56.9	510.2	113.6
13	6	121.4	37.7	282.3	62.8
13	8	60.2	19.8	117.7	26.8
13	10	41.5	13.7	74.7	17.1
14	4	.32	.1	.1	.03
14	6	80.5	24.3	217.2	48.4
14	8	53.5	16.7	124.2	27.9
14	10	49.9	16.1	103.1	23.4
15	5	1.0	.31	3.1	1.1
15	7	24.4	73.8	65.1	14.8
15	9	39.8	12.4	96.1	21.6
15	10	43.1	13.6	98.6	22.2
16	6	1.0	.31	3.2	1.2
16	8	11.7	3.6	31.3	7.3
16	10	27.7	8.6	67.7	15.4
17	6	.22	.06	.68	.25
17	8	2.9	.89	8.2	4.8
17	10	13.6	4.2	34.5	8.0
18	8	.83	.25	2.5	.88
18	10	5.3	1.6	14.0	3.4
19	8	.13	.004	.04	.01
19	10	1.8	.56	5.1	1.4

COMPARISON OF RECEPTORS
WHEN HOT REFUELING CONTRIBUTED
SIGNIFICANT CHANGES
(MICROGRAMS / CUBIC METER)

X	Y	CO (WITH HOT REFUELING)	HC (WITH HOT REFUELING)	CO (WITHOUT HOT REFUELING)	HC (WITHOUT HOT REFUELING)
13	7	7.869E 04	2.566E 04	7.868E 04	2.565E 04
13	8	6.024E 04	1.979E 04	6.023E 04	1.978E 04
13	9	5.038E 04	1.662E 04	5.035E 04	1.661E 04
13	10	4.152E 04	1.374E 04	4.151E 04	1.373E 04
14	7	7.869E 04	2.566E 04	5.515E 04	1.687E 04
14	8	5.345E 04	1.675E 04	5.345E 04	1.674E 04
14	9	5.381E 04	1.717E 04	5.380E 04	1.717E 04
14	10	4.987E 04	1.611E 04	4.986E 04	1.611E 04

TABLE V (CONTINUED)

X	Y	CO (WITH HOT REFUELING)	HC (WITH HOT REFUELING)	CO (WITHOUT HOT REFUELING)	HC (WITHOUT HOT REFUELING)
11	4	4.485E 03	1.834E 03	4.482E 03	1.831E 03
11	5	8.331E 04	2.825E 04	8.322E 04	2.819E 04
11	6	3.843E 04	1.339E 04	3.838E 04	1.335E 04
11	7	1.824E 04	6.168E 03	1.822E 04	6.154E 03
11	8	1.344E 04	4.632E 03	1.343E 04	4.625E 03
11	9	1.117E 04	3.842E 03	1.116E 04	3.837E 03
11	10	9.425E 03	3.244E 03	9.420E 03	3.240E 03
12	6	1.505E 05	5.267E 04	1.504E 05	5.265E 04
12	7	6.304E 04	2.184E 04	6.302E 04	2.182E 04
12	8	3.861E 04	1.315E 04	3.859E 04	1.314E 04
12	9	2.973E 04	1.004E 04	2.972E 04	1.003E 04
12	10	2.369E 04	7.995E 03	2.368E 04	7.988E 03

Because of the 18 percent increase in CO and HC emissions calculated by the Source Inventory Program as a result of hot refueling aircraft, the subsequent predicted dispersions of these two pollutants were compared. It was found that at two kilometers directly downwind from a hot refueling source an increase of only one-tenth of one percent in hourly CO concentration was detected during the greater activity of the daytime simulations. The percentage of increase in the concentrations of HC at this distance was negligible.

VII. CONCLUSIONS AND RECOMMENDATIONS

After intensive investigation of the various intricacies of Argonne National Laboratory's preliminary version of the Source Inventory Program it is concluded that it is based on valid principles. The results obtained from the use of this program when modified as previously denoted should yield quantitative predictions of pollutants emitted with an accuracy equal that of the data used as inputs. These modifications pertain only to carrier type jet aircraft, however. It is therefore recommended that the Source Inventory Program be further modified to include typical flight patterns for helicopters, vertical take-off aircraft and other types of aircraft in use by the US Navy.

In addition, certain inaccuracies will result from the use of the Source Inventory Program unless certain data input areas are expanded. One of these areas is the taxi speed of each aircraft. Presently only one such speed is allowed as input. It is recommended that a modification to allow two taxi speeds be performed or that an additional aircraft area source adjacent to the approach end of each runway be added. Increased accuracy would be gained as a result of accounting for those aircraft waiting at an idle power setting for clearance to take off. In many instances at NAS Miramar this

waiting time exceeded ten minutes but could only be compensated for as a data input by slowing the overall aircraft taxi speed.

It is also recommended that the Source Inventory Program be utilized for a parametric study of the several Naval Air Stations in existence. When utilized in this manner it could provide a valid basis for comparison of different operational procedures on ambient air quality. Some suggested areas for comparison are those of more timely take-off clearances for waiting aircraft and, specifically at NAS Miramar, the effect of allowing aircraft to climb immediately, versus remaining below 2,000 feet until reaching a distance of 14 miles.

No verification of the Short-term Dispersion Program could be made by this study. The subprograms which consititue this model and the mathematical algorithms on which they were based are nearly all theoretical in nature. It is therefore concluded that until such time as its predictions are verified by actual measurement they remain questionable. In view of the great usefulness which the predictions of the Short-term Dispersion Program would be in quantifying an air base as a pollution source it is recommended that it be modified so as to remain compatible with any changes in the Source Inventory Program.

APPENDIX A
WILLIAMS AIR FORCE BASE

SUMMARY OF ANNUAL EMISSIONS IN AIRCRAFT LTO MODES
ALL POLLUTANTS IN METRIC TONS

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	8.007E 02	2.001E 02	2.883E 01	1.599E 02	6.307E 00
TAXI OUT	1.565E 03	3.891E 02	5.525E 01	2.838E 02	1.161E 01
ENGINE CHECK	5.899E 01	1.575E 00	2.041E 01	2.376E 01	2.695E 00
RUNWAY ROLL	1.131E 02	1.910E-01	2.080E 01	3.029E 01	5.855E 00
CLIMB 1	1.378E 02	1.089E 00	2.743E 01	3.571E 01	6.655E 00
CLIMB 2	1.002E 02	3.507E 00	2.056E 01	2.435E 01	3.417E 00
APPROACH 1	4.288E 02	5.467E 01	3.404E 01	1.278E 02	8.258E 00
APPROACH 2	1.416E 02	1.892E 01	1.051E 01	3.681E 01	2.503E 00
LANDING	2.295E 02	5.124E 01	8.056E 00	3.724E 01	1.814E 00
TAXI IN	1.130E 03	2.997E 02	4.020E 01	2.237E 02	8.138E 00
SHUTDOWN	1.077E 02	2.646E 01	3.804E 00	1.940E 01	8.077E-01
ARR + DEP SV	1.507E 02	9.530E 00	3.160E 00	2.338E 00	7.214E-01
FUEL VENTING	0.0	2.188E 02	0.0	0.0	0.0
FILL + SPILL	0.0	6.255E 02	0.0	0.0	0.0
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	9.542E 01	1.057E 01	7.401E 00	2.242E 01	1.761E 00
TOTAL	5.060E 03	1.911E 03	2.805E 02	1.028E 03	6.054E 01

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

OPERATION	CO	HC	NOX	PM	SOX
		VFR APPROACHES			
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0
		TOUCH AND GOS			
CLIMB 1	3.440E 01	9.285E-01	5.626E 00	7.086E 00	1.072E 00
CLIMB 2	1.022E 01	1.237E 00	7.605E-01	2.628E 00	1.860E-01
APPROACH 1	6.578E 01	7.209E 00	5.125E 00	1.530E 01	1.216E 00
APPROACH 2	8.884E 01	1.049E 01	6.694E 00	2.227E 01	1.624E 00
DOWNWIND LEG	9.542E 01	1.057E 01	7.401E 00	2.242E 01	1.761E 00
TOTAL	2.947E 02	3.043E 01	2.561E 01	6.971E 01	5.858E 00
		FCLPS			
CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0

SUMMARY OF ANNUAL EMISSIONS BY AIRCRAFT TYPE
ALL POLLUTANTS IN METRIC TONS

AIRCRAFT NAME

F 5

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	6.184E 01	1.732E 01	2.185E 00	1.237E 01	4.123E-01
TAXI OUT	1.072E 02	3.001E 01	3.787E 00	2.143E 01	7.145E-01
ENGINE CHECK	9.581E 00	3.278E-01	1.109E 00	2.521E 00	2.521E-01
RUNWAY ROLL	1.232E 01	2.346E-02	1.760E 00	2.933E 00	5.865E-01
CLIMB 1	8.668E 00	1.017E-01	1.167E 00	2.130E 00	3.566E-01
CLIMB 2	7.147E 00	3.399E-01	7.875E-01	1.942E 00	1.813E-01
APPROACH 1	3.238E 01	5.248E 00	2.010E 00	1.117E 01	5.583E-01
APPROACH 2	1.043E 01	1.876E 00	6.054E-01	3.369E 00	1.632E-01
LANDING	1.571E 01	4.399E 00	5.552E-01	3.142E 00	1.047E-01
TAXI IN	7.061E 01	1.977E 01	2.495E 00	1.412E 01	4.707E-01
SHUTDOWN	8.163E 00	2.286E 00	2.884E-01	1.633E 00	5.442E-02
ARR + DEP SV	1.252E 01	7.888E-01	2.685E-01	2.014E-01	5.035E-02
FUEL VENTING	0.0	1.297E 01	0.0	0.0	0.0
FILL + SPILL	0.0	2.961E 01	0.0	0.0	0.0
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	6.369E 00	1.032E 00	3.953E-01	2.196E 00	1.098E-01
TOTAL	3.629E 02	1.261E 02	1.741E 01	7.916E 01	4.015E 00

CONTRIBUTUCN OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0

TOUCH AND GOS

CLIMB 1	2.637E 00	9.023E-02	3.054E-01	6.941E-01	6.941E-02
CLIMB 2	7.464E-01	1.210E-01	4.633E-02	2.574E-01	1.287E-02
APPROACH 1	4.346E 00	7.043E-01	2.697E-01	1.498E 00	7.492E-02
APPROACH 2	6.326E 00	1.025E 00	3.927E-01	2.182E 00	1.091E-01
DOWNWIND LEG	6.369E 00	1.032E 00	3.953E-01	2.196E 00	1.098E-01

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

T 37

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.116E 02	8.281E 00	3.564E 00	0.0	1.048E 00
TAXI OUT	2.349E 02	1.743E 01	7.501E 00	0.0	2.206E 00
ENGINE CHECK	1.196E 01	1.161E-02	4.012E 00	0.0	5.806E-01
RUNWAY ROLL	6.787E 00	6.589E-03	2.277E 00	0.0	3.295E-01
CLIMB 1	1.981E 01	1.924E-02	6.646E 00	0.0	9.618E-01
CLIMB 2	2.644E 01	2.533E-02	8.284E 00	0.0	1.212E 00
APPROACH 1	8.866E 01	7.466E-02	9.818E 00	0.0	1.867E 00
APPROACH 2	3.773E 01	4.190E-01	3.762E 00	0.0	7.327E-01
LANDING	6.234E 01	4.624E 00	1.990E 00	0.0	5.853E-01
TAXI IN	7.699E 01	5.711E 00	2.458E 00	0.0	7.229E-01
SHUTDOWN	1.763E 01	1.308E 00	5.628E-01	0.0	1.655E-01
ARR + DEP SV	1.079E 01	7.139E-01	1.586E-01	8.726E-02	1.586E-01
FUEL VENTING	0.0	6.132E 01	0.0	0.0	0.0
FILL + SPILL	0.0	3.113E 02	0.0	0.0	0.0
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	3.038E 01	2.559E-02	3.365E 00	0.0	6.397E-01
TOTAL	7.361E 02	4.113E 02	5.440E 01	8.726E-02	1.121E 01

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0

TOUCH AND GOS

CLIMB 1	7.476E 00	7.259E-03	2.508E 00	0.0	3.629E-01
CLIMB 2	2.596E 00	2.186E-03	2.875E-01	0.0	5.465E-02
APPROACH 1	2.141E 01	1.803E-02	2.371E 00	0.0	4.507E-01
APPROACH 2	2.425E 01	2.042E-02	2.685E 00	0.0	5.104E-01
DOWNWIND LEG	3.038E 01	2.559E-02	3.365E 00	0.0	6.397E-01

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

T 38

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	5.924E 02	1.659E 02	2.093E 01	1.185E 02	3.949E 00
TAXI OUT	1.196E 03	3.347E 02	4.224E 01	2.391E 02	7.970E 00
ENGINE CHECK	3.530E 01	1.208E 00	4.087E 00	9.289E 00	9.289E-01
RUNWAY ROLL	7.810E 01	1.488E-01	1.116E 01	1.860E 01	3.719E 00
CLIMB 1	8.731E 01	9.510E-01	1.182E 01	2.140E 01	3.640E 00
CLIMB 2	6.583E 01	3.131E 00	7.254E 00	1.789E 01	1.670E 00
APPROACH 1	3.013E 02	4.884E 01	1.870E 01	1.039E 02	5.196E 00
APPROACH 2	9.063E 01	1.615E 01	5.293E 00	2.945E 01	1.431E 00
LANDING	1.455E 02	4.074E 01	5.141E 00	2.910E 01	9.700E-01
TAXI IN	9.611E 02	2.691E 02	3.396E 01	1.922E 02	6.407E 00
SHUTDOWN	7.975E 01	2.233E 01	2.818E 00	1.595E 01	5.316E-01
ARR + DEP SV	1.153E 02	7.264E 00	2.473E 00	1.855E 00	4.637E-01
FUEL VENTING	0.0	1.195E 02	0.0	0.0	0.0
FILL + SPILL	0.0	2.563E 02	0.0	0.0	0.0
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	5.866E 01	9.507E 00	3.641E 00	2.023E 01	1.011E 00
TOTAL	3.807E 03	1.296E 03	1.695E 02	3.175E 02	3.789E 01

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0

TOUCH AND GOS

CLIMB 1	2.429E 01	8.310E-01	2.813E 00	6.392E 00	6.392E-01
CLIMB 2	6.874E 00	1.114E 00	4.267E-01	2.370E 00	1.185E-01
APPROACH 1	4.002E 01	6.486E 00	2.484E 00	1.380E 01	6.900E-01
APPROACH 2	5.827E 01	9.443E 00	3.617E 00	2.009E 01	1.005E 00
DOWNWIND LEG	5.866E 01	9.507E 00	3.641E 00	2.023E 01	1.011E 00

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

TRANSENT

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	3.482E 01	8.616E 00	2.154E 00	2.908E 01	8.975E-01
TAXI OUT	2.786E 01	6.893E 00	1.723E 00	2.326E 01	7.180E-01
ENGINE CHECK	2.148E 00	2.801E-02	1.121E 01	1.195E 01	9.338E-01
RUNWAY ROLL	1.586E 01	1.220E-02	5.610E 00	8.757E 00	1.220E 00
CLIMB 1	2.205E 01	1.696E-02	7.802E 00	1.218E 01	1.696E 00
CLIMB 2	6.125E-01	1.060E-02	4.239E 00	4.522E 00	3.533E-01
APPROACH 1	6.373E 00	5.098E-01	3.505E 00	1.275E 01	6.373E-01
APPROACH 2	2.855E 00	4.750E-01	8.511E-01	3.994E 00	1.762E-01
LANDING	5.981E 00	1.480E 00	3.699E-01	4.994E 00	1.541E-01
TAXI IN	2.084E 01	5.156E 00	1.289E 00	1.740E 01	5.371E-01
SHUTDOWN	2.176E 00	5.385E-01	1.346E-01	1.817E 00	5.610E-02
ARR + DEP SV	1.210E 01	7.625E-01	2.596E-01	1.947E-01	4.867E-02
FUEL VENTING	0.0	2.506E 01	0.0	0.0	0.0
FILL + SPILL	0.0	2.821E 01	0.0	0.0	0.0
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
TOTAL	1.539E 02	7.779E 01	3.914E 01	1.309E 02	7.428E 00

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0

TOUCH AND GOS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

NAS MIRAMAR HOT REFUELING

SUMMARY OF ANNUAL EMISSIONS IN AIRCRAFT LTO MODES
ALL POLLUTANTS IN METRIC TONS

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	7.408E 04	3.258E 04	4.001E 03	5.390E 03	1.252E-01
TAXI OUT	2.212E 05	8.977E 04	1.216E 04	1.054E 04	5.729E-02
ENGINE CHECK	1.642E 03	8.155E 02	1.066E 04	7.654E-01	7.654E-02
RUNWAY ROLL	8.832E 04	4.998E 03	3.630E 04	5.932E 03	1.681E-01
CLIMB 1	1.241E 05	1.261E 04	1.328E 05	1.775E 04	9.904E-02
CLIMB 2	2.057E 04	6.971E 03	7.908E 04	1.787E 04	5.920E-02
APPROACH 1	3.614E 04	1.103E 04	1.136E 05	3.416E 04	2.741E-02
APPROACH 2	3.505E 04	1.094E 04	1.035E 05	3.282E 04	3.276E-02
LANDING	3.912E 03	3.134E 03	1.407E 02	9.582E 00	0.0
TAXI IN	7.962E 05	3.521E 05	4.217E 04	3.154E 04	3.059E-01
SHUTDOWN	5.086E 05	2.070E 05	2.839E 04	4.276E 04	1.831E-02
ARR + DEP SV	3.368E 01	3.516E 00	1.760E 00	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	5.370E 01	0.0	0.0	0.0
BREAK ENTRY	8.251E 03	2.498E 03	2.625E 04	1.100E 04	4.398E-02
BREAK TURN	3.398E 03	1.029E 03	1.081E 04	4.528E 03	1.811E-02
DOWNWIND LEG	3.698E 04	1.111E 04	1.118E 05	3.479E 04	3.812E-02
TOTAL	1.958E 06	7.467E 05	7.118E 05	2.491E 05	1.070E 00

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

OPERATION	CO	HC	NOX	PM	SOX
		VFR APPROACHES			
BREAK ENTRY	8.251E 03	2.498E 03	2.625E 04	1.100E 04	4.398E-02
BREAK TURN	3.398E 03	1.029E 03	1.081E 04	4.528E 03	1.811E-02
DOWNWIND LEG	9.293E 03	2.807E 03	3.036E 04	1.351E 04	1.935E-02
APPROACH 1	5.978E 03	1.804E 03	1.974E 04	8.986E 03	1.459E-02
APPROACH 2	5.795E 03	1.749E 03	1.913E 04	8.711E 03	1.412E-02
TOTAL	3.272E 04	9.886E 03	1.063E 05	4.673E 04	1.101E-01
		TOUCH AND GOS			
CLIMB 1	2.712E 03	1.152E 03	1.758E 04	2.996E 03	1.186E-02
CLIMB 2	2.537E 03	7.598E 02	8.380E 03	2.613E 03	8.067E-03
APPROACH 1	3.742E 03	1.087E 03	1.392E 04	7.561E 03	1.282E-02
APPROACH 2	3.628E 03	1.053E 03	1.349E 04	7.330E 03	1.864E-02
DOWNWIND LEG	6.261E 03	1.844E 03	2.221E 04	9.939E 03	1.877E-02
TOTAL	1.888E 04	5.897E 03	7.558E 04	3.044E 04	7.016E-02
		FCLPS			
CLIMB 1	1.365E 04	5.576E 03	7.268E 04	7.852E 03	0.0
CLIMB 2	1.139E 04	3.425E 03	3.112E 04	6.840E 03	0.0
APPROACH 1	2.536E 04	7.621E 03	7.114E 04	1.723E 04	0.0
APPROACH 2	2.462E 04	7.398E 03	6.905E 04	1.673E 04	0.0
DOWNWIND LEG	2.142E 04	6.459E 03	5.928E 04	1.134E 04	0.0
TOTAL	9.644E 04	3.048E 04	3.033E 05	6.000E 04	0.0

SUMMARY OF ANNUAL EMISSIONS BY AIRCRAFT TYPE
ALL POLLUTANTS IN METRIC TONS

AIRCRAFT NAME

F 4

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	3.833E 04	7.866E 03	2.378E 03	0.0	0.0
TAXI OUT	1.375E 05	2.823E 04	8.535E 03	0.0	0.0
ENGINE CHECK	1.603E 03	6.326E 02	6.495E 03	0.0	0.0
RUNWAY ROLL	4.798E 04	4.443E 03	2.488E 04	0.0	0.0
CLIMB 1	6.978E 04	1.072E 04	8.604E 04	0.0	0.0
CLIMB 2	1.609E 04	5.491E 03	4.476E 04	0.0	0.0
APPROACH 1	2.608E 04	8.072E 03	5.278E 04	0.0	0.0
APPROACH 2	2.516E 04	7.785E 03	5.087E 04	0.0	0.0
LANDING	7.817E 01	1.604E 01	4.851E 00	0.0	0.0
TAXI IN	4.645E 05	9.534E 04	2.882E 04	0.0	0.0
SHUTDOWN	2.911E 05	5.976E 04	1.807E 04	0.0	0.0
ARR + DEP SV	4.582E 00	4.498E-01	3.936E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	2.765E 01	0.0	0.0	0.0
BREAK ENTRY	6.645E 03	2.057E 03	1.345E 04	0.0	0.0
BREAK TURN	2.737E 03	8.470E 02	5.538E 03	0.0	0.0
DOWNWIND LEG	2.667E 04	8.254E 03	5.397E 04	0.0	0.0
TOTAL	1.154E 06	2.395E 05	3.966E 05	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

	CO	HC	NOX	PM	SOX
VFR APPROACHES					
BREAK ENTRY	6.645E 03	2.057E 03	1.345E 04	0.0	0.0
BREAK TURN	2.737E 03	8.470E 02	5.538E 03	0.0	0.0
DOWNWIND LEG	7.403E 03	2.291E 03	1.498E 04	0.0	0.0
APPROACH 1	4.740E 03	1.467E 03	9.593E 03	0.0	0.0
APPROACH 2	4.595E 03	1.422E 03	9.300E 03	0.0	0.0
TOUCH AND GOS					
CLIMB 1	2.136E 03	8.432E 02	8.656E 03	0.0	0.0
CLIMB 2	1.526E 03	4.724E 02	3.089E 03	0.0	0.0
APPROACH 1	2.350E 03	7.275E 02	4.757E 03	0.0	0.0
APPROACH 2	2.279E 03	7.053E 02	4.611E 03	0.0	0.0
DOWNWIND LEG	3.851E 03	1.192E 03	7.794E 03	0.0	0.0
FCLPS					
CLIMB 1	1.197E 04	4.726E 03	4.852E 04	0.0	0.0
CLIMB 2	8.543E 03	2.644E 03	1.729E 04	0.0	0.0
APPROACH 1	1.879E 04	5.815E 03	3.802E 04	0.0	0.0
APPROACH 2	1.824E 04	5.645E 03	3.691E 04	0.0	0.0
DOWNWIND LEG	1.541E 04	4.770E 03	3.119E 04	0.0	0.0

RF-8G

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	4.035E 02	3.951E 02	1.670E 01	0.0	0.0
TAXI OUT	9.592E 03	9.393E 03	3.971E 02	0.0	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY ROLL	6.993E 03	1.086E 02	9.339E 02	0.0	0.0
CLIMB 1	1.235E 04	5.345E 02	7.442E 03	0.0	0.0
CLIMB 2	1.736E 03	4.220E 02	3.840E 03	0.0	0.0
APPROACH 1	3.287E 03	7.644E 02	6.268E 03	0.0	0.0
APPROACH 2	3.183E 03	7.417E 02	6.066E 03	0.0	0.0
LANDING	5.878E 00	5.756E 00	2.434E-01	0.0	0.0
TAXI IN	5.029E 04	4.925E 04	2.082E 03	0.0	0.0
SHUTDOWN	2.205E 04	2.159E 04	9.128E 02	0.0	0.0
ARR + DEP SV	4.368E-01	4.288E-02	3.752E-02	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	1.896E 00	0.0	0.0	0.0
BREAK ENTRY	3.489E 02	8.113E 01	6.653E 02	0.0	0.0
BREAK TURN	1.437E 02	3.341E 01	2.740E 02	0.0	0.0
DOWNWIND LEG	3.753E 03	8.729E 02	7.158E 03	0.0	0.0
TOTAL	1.141E 05	8.420E 04	3.606E 04	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIEP

LANDING PRACTICE TO THIS SUMMARY

		VFR APPROACHES			
BREAK ENTRY	3.489E 02	8.113E 01	6.653E 02	0.0	0.0
BREAK TURN	1.437E 02	3.341E 01	2.740E 02	0.0	0.0
DOWNWIND LEG	3.814E 02	8.870E 01	7.274E 02	0.0	0.0
APPROACH 1	2.426E 02	5.641E 01	4.626E 02	0.0	0.0
APPROACH 2	2.352E 02	5.469E 01	4.484E 02	0.0	0.0
		TOUCH AND GOS			
CLIMB 1	2.273E 02	8.840E 01	1.465E 03	0.0	0.0
CLIMB 2	4.016E 02	9.340E 01	7.659E 02	0.0	0.0
APPROACH 1	4.228E 02	9.833E 01	8.063E 02	0.0	0.0
APPROACH 2	4.099E 02	9.532E 01	7.816E 02	0.0	0.0
DOWNWIND LEG	8.239E 02	1.916E 02	1.571E 03	0.0	0.0
		FCLPS			
CLIMB 1	6.905E 02	2.685E 02	4.450E 03	0.0	0.0
CLIMB 2	1.218E 03	2.834E 02	2.324E 03	0.0	0.0
APPROACH 1	2.611E 03	6.073E 02	4.980E 03	0.0	0.0
APPROACH 2	2.535E 03	5.895E 02	4.833E 03	0.0	0.0
DOWNWIND LEG	2.548E 03	5.926E 02	4.859E 03	0.0	0.0

F-8J

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.020E 03	8.731E 02	2.888E 01	0.0	0.0
TAXI OUT	1.507E 04	1.290E 04	4.266E 02	0.0	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY ROLL	5.876E 03	2.295E 02	3.121E 03	0.0	0.0
CLIMB 1	9.565E 03	9.919E 02	2.071E 04	0.0	0.0
CLIMB 2	1.689E 03	6.356E 02	1.042E 04	0.0	0.0
APPROACH 1	3.584E 03	1.254E 03	1.900E 04	0.0	0.0
APPROACH 2	3.474E 03	1.219E 03	1.838E 04	0.0	0.0
LANDING	1.623E 01	1.389E 01	4.594E-01	0.0	0.0
TAXI IN	1.161E 05	9.932E 04	3.284E 03	0.0	0.0
SHUTDOWN	5.544E 04	4.745E 04	1.569E 03	0.0	0.0
ARR + DEP SV	7.733E-01	7.590E-02	6.642E-02	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	3.078E 00	0.0	0.0	0.0
BREAK ENTRY	3.391E 02	1.187E 02	1.797E 03	0.0	0.0
BREAK TURN	1.396E 02	4.888E 01	7.401E 02	0.0	0.0
DOWNWIND LEG	3.967E 03	1.389E 03	2.103E 04	0.0	0.0
TOTAL	2.162E 05	1.664E 05	1.005E 05	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

		VFR APPROACHES			
BREAK ENTRY	3.391E 02	1.187E 02	1.797E 03	0.0	0.0
BREAK TURN	1.396E 02	4.888E 01	7.401E 02	0.0	0.0
DOWNWIND LEG	4.023E 02	1.408E 02	2.132E 03	0.0	0.0
APPROACH 1	2.638E 02	9.235E 01	1.398E 03	0.0	0.0
APPROACH 2	2.558E 02	8.952E 01	1.356E 03	0.0	0.0

		TOUCH AND GOS			
CLIMB 1	2.154E 02	1.615E 02	3.985E 03	0.0	0.0
CLIMB 2	3.914E 02	1.370E 02	2.074E 03	0.0	0.0
APPROACH 1	4.611E 02	1.614E 02	2.444E 03	0.0	0.0
APPROACH 2	4.469E 02	1.564E 02	2.369E 03	0.0	0.0
DOWNWIND LEG	8.711E 02	3.049E 02	4.617E 03	0.0	0.0

		FCLPS			
CLIMB 1	6.542E 02	4.907E 02	1.210E 04	0.0	0.0
CLIMB 2	1.187E 03	4.155E 02	6.292E 03	0.0	0.0
APPROACH 1	2.848E 03	9.968E 02	1.509E 04	0.0	0.0
APPROACH 2	2.764E 03	9.675E 02	1.465E 04	0.0	0.0
DOWNWIND LEG	2.694E 03	9.429E 02	1.428E 04	0.0	0.0

F-14

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.555E 04	8.150E 03	9.146E 02	5.386E 03	0.0
TAXI OUT	3.041E 04	1.594E 04	1.789E 03	1.053E 04	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY ROLL	2.744E 04	1.107E 02	4.947E 03	5.931E 03	0.0
CLIMB 1	3.237E 04	2.202E 02	1.550E 04	1.775E 04	0.0
CLIMB 2	9.066E 02	1.498E 02	1.414E 04	1.787E 04	0.0
APPROACH 1	1.993E 03	2.847E 02	2.377E 04	3.416E 04	0.0
APPROACH 2	1.924E 03	2.786E 02	2.283E 04	3.282E 04	0.0
LANDING	2.766E 01	1.450E 01	1.627E 00	9.582E 00	0.0
TAXI IN	9.103E 04	4.772E 04	5.355E 03	3.153E 04	0.0
SHUTDOWN	1.234E 05	6.470E 04	7.260E 03	4.276E 04	0.0
ARR + DEP SV	2.424E 00	2.380E-01	2.082E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	9.005E 00	0.0	0.0	0.0
BREAK ENTRY	6.413E 02	9.162E 01	7.650E 03	1.099E 04	0.0
BREAK TURN	2.641E 02	3.773E 01	3.150E 03	4.528E 03	0.0
DOWNWIND LEG	2.029E 03	2.899E 02	2.421E 04	3.479E 04	0.0
TOTAL	3.280E 05	1.380E 05	1.315E 05	2.491E 05	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	6.413E 02	9.162E 01	7.650E 03	1.099E 04	0.0
BREAK TURN	2.641E 02	3.773E 01	3.150E 03	4.528E 03	0.0
DOWNWIND LEG	7.878E 02	1.125E 02	9.397E 03	1.351E 04	0.0
APPROACH 1	5.242E 02	7.488E 01	6.253E 03	8.986E 03	0.0
APPROACH 2	5.081E 02	7.259E 01	6.061E 03	8.711E 03	0.0

TOUCH AND GOS

CLIMB 1	1.264E 02	2.528E 01	2.692E 03	2.996E 03	0.0
CLIMB 2	1.524E 02	2.178E 01	1.818E 03	2.613E 03	0.0
APPROACH 1	4.411E 02	6.301E 01	5.261E 03	7.561E 03	0.0
APPROACH 2	4.276E 02	6.108E 01	5.100E 03	7.329E 03	0.0
DOWNWIND LEG	5.798E 02	8.283E 01	6.916E 03	9.939E 03	0.0

FCLPS

CLIMB 1	3.313E 02	6.626E 01	7.057E 03	7.852E 03	0.0
CLIMB 2	3.990E 02	5.700E 01	4.760E 03	6.840E 03	0.0
APPROACH 1	1.005E 03	1.436E 02	1.199E 04	1.723E 04	0.0
APPROACH 2	9.759E 02	1.394E 02	1.164E 04	1.673E 04	0.0
DOWNWIND LEG	6.617E 02	9.452E 01	7.893E 03	1.134E 04	0.0

A-4

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	9.002E 02	7.335E 02	3.175E 01	0.0	0.0
TAXI OUT	2.143E 04	1.746E 04	7.560E 02	0.0	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY ROLL	9.708E 00	4.854E 01	1.107E 03	0.0	0.0
CLIMB 1	1.845E 01	9.223E 01	2.103E 03	0.0	0.0
CLIMB 2	1.358E 02	1.866E 02	3.965E 03	0.0	0.0
APPROACH 1	3.889E 02	2.122E 02	3.819E 03	0.0	0.0
APPROACH 2	3.743E 02	2.054E 02	3.630E 03	0.0	0.0
LANDING	1.304E 01	1.062E 01	4.599E-01	0.0	0.0
TAXI IN	6.055E 04	4.934E 04	2.136E 03	0.0	0.0
SHUTDOWN	1.542E 04	1.256E 04	5.439E 02	0.0	0.0
ARR + DEP SV	1.426E 01	1.520E 00	5.859E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	6.706E 00	0.0	0.0	0.0
BREAK ENTRY	2.740E 02	1.495E 02	2.690E 03	0.0	0.0
BREAK TURN	1.128E 02	6.155E 01	1.108E 03	0.0	0.0
DOWNWIND LEG	5.594E 02	3.051E 02	5.492E 03	0.0	0.0
TOTAL	1.002E 05	8.138E 04	2.738E 04	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	2.740E 02	1.495E 02	2.690E 03	0.0	0.0
BREAK TURN	1.128E 02	6.155E 01	1.108E 03	0.0	0.0
DOWNWIND LEG	3.179E 02	1.734E 02	3.121E 03	0.0	0.0
APPROACH 1	2.067E 02	1.127E 02	2.029E 03	0.0	0.0
APPROACH 2	2.003E 02	1.093E 02	1.967E 03	0.0	0.0

TOUCH AND GOS

CLIMB 1	6.814E 00	3.407E 01	7.768E 02	0.0	0.0
CLIMB 2	6.443E 01	3.514E 01	6.326E 02	0.0	0.0
APPROACH 1	6.637E 01	3.620E 01	6.516E 02	0.0	0.0
APPRCACH 2	6.434E 01	3.509E 01	6.317E 02	0.0	0.0
DOWNWIND LEG	1.336E 02	7.285E 01	1.311E 03	0.0	0.0

FCLPS

CLIMB 1	4.881E 00	2.441E 01	5.565E 02	0.0	0.0
CLIMB 2	4.609E 01	2.514E 01	4.525E 02	0.0	0.0
APPROACH 1	1.072E 02	5.845E 01	1.052E 03	0.0	0.0
APPROACH 2	1.040E 02	5.674E 01	1.021E 03	0.0	0.0
DOWNWIND LEG	1.080E 02	5.889E 01	1.060E 03	0.0	0.0

F 5

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.877E 01	5.257E 00	6.633E-01	3.755E 00	1.252E-01
TAXI OUT	8.594E 00	2.406E 00	3.037E-01	1.719E 00	5.729E-02
ENGINE CHECK	2.908E 00	9.950E-02	3.368E-01	7.654E-01	7.654E-02
RUNWAY ROLL	3.531E 00	6.725E-03	5.044E-01	8.406E-01	1.681E-01
CLIMB 1	2.281E 00	1.891E-02	3.137E-01	5.545E-01	9.904E-02
CLIMB 2	2.411E 00	1.423E-01	2.540E-01	6.727E-01	5.920E-02
APPROACH 1	1.590E 00	2.576E-01	9.867E-02	5.482E-01	2.741E-02
APPROACH 2	1.900E 00	3.079E-01	1.179E-01	6.551E-01	3.276E-02
LANDING	0.0	0.0	0.0	0.0	0.0
TAXI IN	4.588E 01	1.285E 01	1.621E 00	9.176E 00	3.059E-01
SHUTDOWN	2.747E 00	7.691E-01	9.705E-02	5.493E-01	1.831E-02
ARR + DEP SV	4.031E 00	4.303E-01	1.627E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	1.010E 00	0.0	0.0	0.0
BREAK ENTRY	2.551E 00	4.134E-01	1.583E-01	8.796E-01	4.398E-02
BREAK TURN	1.050E 00	1.702E-01	6.520E-02	3.622E-01	1.811E-02
DOWNWIND LEG	2.211E 00	3.583E-01	1.372E-01	7.624E-01	3.812E-02
TOTAL	1.005E 02	2.449E 01	4.834E 00	2.124E 01	1.070E 00

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	2.551E 00	4.134E-01	1.583E-01	8.796E-01	4.398E-02
BREAK TURN	1.050E 00	1.702E-01	6.520E-02	3.622E-01	1.811E-02
DOWNWIND LEG	1.122E 00	1.819E-01	6.967E-02	3.870E-01	1.935E-02
APPROACH 1	8.461E-01	1.371E-01	5.252E-02	2.918E-01	1.459E-02
APPROACH 2	8.188E-01	1.327E-01	5.082E-02	2.823E-01	1.412E-02

TOUCH AND GOS

CLIMB 1	4.507E-01	1.542E-02	5.219E-02	1.186E-01	1.186E-02
CLIMB 2	4.679E-01	7.583E-02	2.904E-02	1.613E-01	8.067E-03
APPROACH 1	7.435E-01	1.205E-01	4.615E-02	2.564E-01	1.282E-02
APPROACH 2	1.081E 00	1.752E-01	6.711E-02	3.728E-01	1.864E-02
DOWNWIND LEG	1.089E 00	1.764E-01	6.756E-02	3.754E-01	1.877E-02

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

TRANSENT

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.787E 04	1.456E 04	6.302E 02	0.0	0.0
TAXI OUT	7.173E 03	5.845E 03	2.530E 02	0.0	0.0
ENGINE CHECK	3.655E 01	1.828E 02	4.167E 03	0.0	0.0
RUNWAY ROLL	1.155E 01	5.773E 01	1.316E 03	0.0	0.0
CLIMB 1	9.210E 00	4.605E 01	1.050E 03	0.0	0.0
CLIMB 2	1.715E 01	8.576E 01	1.955E 03	0.0	0.0
APPROACH 1	8.080E 02	4.407E 02	7.933E 03	0.0	0.0
APPROACH 2	9.310E 02	7.114E 02	1.747E 03	0.0	0.0
LANDING	3.772E 03	3.073E 03	1.330E 02	0.0	0.0
TAXI IN	1.369E 04	1.115E 04	4.828E 02	0.0	0.0
SHUTDOWN	1.117E 03	9.099E 02	3.939E 01	0.0	0.0
ARR + DEP SV	7.178E 00	7.594E-01	3.261E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	4.359E 00	0.0	0.0	0.0
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
TOTAL	4.544E 04	3.707E 04	1.971E 04	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0

TOUCH AND GOS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

NAS MIRAMAR NO HOT REFUELING

SUMMARY OF ANNUAL EMISSIONS IN AIRCRAFT LTO MODES
ALL POLLUTANTS IN METRIC TONS

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	7.408E 04	3.258E 04	4.001E 03	5.390E 03	1.252E-01
TAXI OUT	2.212E 05	8.977E 04	1.216E 04	1.054E 04	5.729E-02
ENGINE CHECK	1.642E 03	8.155E 02	1.066E 04	7.654E-01	7.654E-02
RUNWAY ROLL	8.832E 04	4.998E 03	3.630E 04	5.932E 03	1.681E-01
CLIMB 1	1.241E 05	1.261E 04	1.328E 05	1.775E 04	9.904E-02
CLIMB 2	2.057E 04	6.971E 03	7.908E 04	1.787E 04	5.920E-02
APPROACH 1	3.614E 04	1.103E 04	1.136E 05	3.416E 04	2.741E-02
APPROACH 2	3.505E 04	1.094E 04	1.035E 05	3.282E 04	3.276E-02
LANDING	3.912E 03	3.134E 03	1.407E 02	9.582E 00	0.0
TAXI IN	7.962E 05	3.521E 05	4.217E 04	3.154E 04	3.059E-01
SHUTDOWN	2.011E 05	8.876E 04	1.106E 04	2.138E 04	1.831E-02
ARR + DEP SV	8.934E 01	9.512E 00	3.736E 00	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	5.370E 01	0.0	0.0	0.0
BREAK ENTRY	8.251E 03	2.498E 03	2.625E 04	1.100E 04	4.398E-02
BREAK TURN	3.398E 03	1.029E 03	1.081E 04	4.528E 03	1.811E-02
DOWNWIND LEG	3.698E 04	1.111E 04	1.118E 05	3.479E 04	3.812E-02
TOTAL	1.651E 06	6.284E 05	6.944E 05	2.277E 05	1.070E 00

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

OPERATION	CO	HC	NOX	PM	SOX
		VFR APPROACHES			
BREAK ENTRY	8.251E 03	2.498E 03	2.625E 04	1.100E 04	4.398E-02
BREAK TURN	3.398E 03	1.029E 03	1.081E 04	4.528E 03	1.811E-02
DOWNWIND LEG	9.293E 03	2.807E 03	3.036E 04	1.351E 04	1.935E-02
APPROACH 1	5.978E 03	1.804E 03	1.974E 04	8.986E 03	1.459E-02
APPROACH 2	5.795E 03	1.749E 03	1.913E 04	8.711E 03	1.412E-02
TOTAL	3.272E 04	9.886E 03	1.063E 05	4.673E 04	1.101E-01
		TOUCH AND GOS			
CLIMB 1	2.712E 03	1.152E 03	1.758E 04	2.996E 03	1.186E-02
CLIMB 2	2.537E 03	7.598E 02	8.380E 03	2.613E 03	8.067E-03
APPROACH 1	3.742E 03	1.087E 03	1.392E 04	7.561E 03	1.282E-02
APPROACH 2	3.628E 03	1.053E 03	1.349E 04	7.330E 03	1.864E-02
DOWNWIND LEG	6.261E 03	1.844E 03	2.221E 04	9.939E 03	1.877E-02
TOTAL	1.888E 04	5.897E 03	7.558E 04	3.044E 04	7.016E-02
		FCLPS			
CLIMB 1	1.365E 04	5.576E 03	7.268E 04	7.852E 03	0.0
CLIMB 2	1.139E 04	3.425E 03	3.112E 04	6.840E 03	0.0
APPROACH 1	2.536E 04	7.621E 03	7.114E 04	1.723E 04	0.0
APPROACH 2	2.462E 04	7.398E 03	6.905E 04	1.673E 04	0.0
DOWNWIND LEG	2.142E 04	6.459E 03	5.928E 04	1.134E 04	0.0
TOTAL	9.644E 04	3.048E 04	3.033E 05	6.000E 04	0.0

SUMMARY OF ANNUAL EMISSIONS BY AIRCRAFT TYPE
ALL POLLUTANTS IN METRIC TONS

AIRCRAFT NAME

F 4

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	3.833E 04	7.866E 03	2.378E 03	0.0	0.0
TAXI OUT	1.375E 05	2.823E 04	8.535E 03	0.0	0.0
ENGINE CHECK	1.603E 03	6.326E 02	6.495E 03	0.0	0.0
RUNWAY ROLL	4.798E 04	4.443E 03	2.488E 04	0.0	0.0
CLIMB 1	6.978E 04	1.072E 04	8.604E 04	0.0	0.0
CLIMB 2	1.609E 04	5.491E 03	4.476E 04	0.0	0.0
APPROACH 1	2.608E 04	8.072E 03	5.278E 04	0.0	0.0
APPROACH 2	2.516E 04	7.785E 03	5.087E 04	0.0	0.0
LANDING	7.817E 01	1.604E 01	4.851E 00	0.0	0.0
TAXI IN	4.645E 05	9.534E 04	2.882E 04	0.0	0.0
SHUTDOWN	9.705E 04	1.992E 04	6.022E 03	0.0	0.0
ARR + DEP SV	4.087E 01	4.359E 00	1.668E 00	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	2.765E 01	0.0	0.0	0.0
BREAK ENTRY	6.645E 03	2.057E 03	1.345E 04	0.0	0.0
BREAK TURN	2.737E 03	8.470E 02	5.538E 03	0.0	0.0
DOWNWIND LEG	2.667E 04	8.254E 03	5.397E 04	0.0	0.0
TOTAL	9.603E 05	1.997E 05	3.845E 05	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

	CO	HC	NOX	PM	SOX
		VFR APPROACHES			
BREAK ENTRY	6.645E 03	2.057E 03	1.345E 04	0.0	0.0
BREAK TURN	2.737E 03	8.470E 02	5.538E 03	0.0	0.0
DOWNWIND LEG	7.403E 03	2.291E 03	1.498E 04	0.0	0.0
APPROACH 1	4.740E 03	1.467E 03	9.593E 03	0.0	0.0
APPROACH 2	4.595E 03	1.422E 03	9.300E 03	0.0	0.0
		TOUCH AND GOS			
CLIMB 1	2.136E 03	8.432E 02	8.656E 03	0.0	0.0
CLIMB 2	1.526E 03	4.724E 02	3.089E 03	0.0	0.0
APPROACH 1	2.350E 03	7.275E 02	4.757E 03	0.0	0.0
APPROACH 2	2.279E 03	7.053E 02	4.611E 03	0.0	0.0
DOWNWIND LEG	3.851E 03	1.192E 03	7.794E 03	0.0	0.0
		FCLPS			
CLIMB 1	1.197E 04	4.726E 03	4.852E 04	0.0	0.0
CLIMB 2	8.543E 03	2.644E 03	1.729E 04	0.0	0.0
APPROACH 1	1.879E 04	5.815E 03	3.802E 04	0.0	0.0
APPROACH 2	1.824E 04	5.645E 03	3.691E 04	0.0	0.0
DOWNWIND LEG	1.541E 04	4.770E 03	3.119E 04	0.0	0.0

RF-8G

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	4.035E 02	3.951E 02	1.670E 01	0.0	0.0
TAXI OUT	9.592E 03	9.393E 03	3.971E 02	0.0	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY ROLL	6.993E 03	1.086E 02	9.339E 02	0.0	0.0
CLIMB 1	1.235E 04	5.345E 02	7.442E 03	0.0	0.0
CLIMB 2	1.736E 03	4.220E 02	3.840E 03	0.0	0.0
APPROACH 1	3.287E 03	7.644E 02	6.268E 03	0.0	0.0
APPROACH 2	3.183E 03	7.417E 02	6.066E 03	0.0	0.0
LANDING	5.878E 00	5.756E 00	2.434E-01	0.0	0.0
TAXI IN	5.029E 04	4.925E 04	2.082E 03	0.0	0.0
SHUTDOWN	7.349E 03	7.197E 03	3.043E 02	0.0	0.0
ARR + DEP SV	4.170E 00	4.450E-01	1.686E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	1.896E 00	0.0	0.0	0.0
BREAK ENTRY	3.489E 02	8.113E 01	6.653E 02	0.0	0.0
BREAK TURN	1.437E 02	3.341E 01	2.740E 02	0.0	0.0
DOWNWIND LEG	3.753E 03	8.729E 02	7.158E 03	0.0	0.0
TOTAL	9.944E 04	6.980E 04	3.545E 04	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

		VFR APPROACHES			
BREAK ENTRY	3.489E 02	8.113E 01	6.653E 02	0.0	0.0
BREAK TURN	1.437E 02	3.341E 01	2.740E 02	0.0	0.0
DOWNWIND LEG	3.814E 02	8.870E 01	7.274E 02	0.0	0.0
APPROACH 1	2.426E 02	5.641E 01	4.626E 02	0.0	0.0
APPROACH 2	2.352E 02	5.469E 01	4.484E 02	0.0	0.0
		TOUCH AND GOS			
CLIMB 1	2.273E 02	8.840E 01	1.465E 03	0.0	0.0
CLIMB 2	4.016E 02	9.340E 01	7.659E 02	0.0	0.0
APPROACH 1	4.228E 02	9.833E 01	8.063E 02	0.0	0.0
APPROACH 2	4.099E 02	9.532E 01	7.816E 02	0.0	0.0
DOWNWIND LEG	8.239E 02	1.916E 02	1.571E 03	0.0	0.0
		FCLPS			
CLIMB 1	6.905E 02	2.685E 02	4.450E 03	0.0	0.0
CLIMB 2	1.218E 03	2.834E 02	2.324E 03	0.0	0.0
APPROACH 1	2.611E 03	6.073E 02	4.980E 03	0.0	0.0
APPROACH 2	2.535E 03	5.895E 02	4.833E 03	0.0	0.0
DOWNWIND LEG	2.548E 03	5.926E 02	4.859E 03	0.0	0.0

F-8J

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.020E 03	8.731E 02	2.888E 01	0.0	0.0
TAXI OUT	1.507E 04	1.290E 04	4.266E 02	0.0	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY RCLL	5.876E 03	2.295E 02	3.121E 03	0.0	0.0
CLIMB 1	9.565E 03	9.919E 02	2.071E 04	0.0	0.0
CLIMB 2	1.689E 03	6.356E 02	1.042E 04	0.0	0.0
APPROACH 1	3.584E 03	1.254E 03	1.900E 04	0.0	0.0
APPROACH 2	3.474E 03	1.219E 03	1.838E 04	0.0	0.0
LANDING	1.623E 01	1.389E 01	4.594E-01	0.0	0.0
TAXI IN	1.161E 05	9.932E 04	3.284E 03	0.0	0.0
SHUTDOWN	1.848E 04	1.582E 04	5.231E 02	0.0	0.0
ARR + DEP SV	7.345E 00	7.838E-01	2.973E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	3.078E 00	0.0	0.0	0.0
BREAK ENTRY	3.391E 02	1.187E 02	1.797E 03	0.0	0.0
BREAK TURN	1.396E 02	4.888E 01	7.401E 02	0.0	0.0
DOWNWIND LEG	3.967E 03	1.389E 03	2.103E 04	0.0	0.0
TOTAL	1.793E 05	1.348E 05	9.945E 04	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

		VFR APPROACHES			
BREAK ENTRY	3.391E 02	1.187E 02	1.797E 03	0.0	0.0
BREAK TURN	1.396E 02	4.888E 01	7.401E 02	0.0	0.0
DOWNWIND LEG	4.023E 02	1.408E 02	2.132E 03	0.0	0.0
APPROACH 1	2.638E 02	9.235E 01	1.398E 03	0.0	0.0
APPROACH 2	2.558E 02	8.952E 01	1.356E 03	0.0	0.0
		TOUCH AND GOS			
CLIMB 1	2.154E 02	1.615E 02	3.985E 03	0.0	0.0
CLIMB 2	3.914E 02	1.370E 02	2.074E 03	0.0	0.0
APPROACH 1	4.611E 02	1.614E 02	2.444E 03	0.0	0.0
APPROACH 2	4.469E 02	1.564E 02	2.369E 03	0.0	0.0
DOWNWIND LEG	8.711E 02	3.049E 02	4.617E 03	0.0	0.0
		FCLPS			
CLIMB 1	6.542E 02	4.907E 02	1.210E 04	0.0	0.0
CLIMB 2	1.187E 03	4.155E 02	6.292E 03	0.0	0.0
APPROACH 1	2.848E 03	9.968E 02	1.509E 04	0.0	0.0
APPROACH 2	2.764E 03	9.675E 02	1.465E 04	0.0	0.0
DOWNWIND LEG	2.694E 03	9.429E 02	1.428E 04	0.0	0.0

F-14

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.555E 04	8.150E 03	9.146E 02	5.386E 03	0.0
TAXI OUT	3.041E 04	1.594E 04	1.789E 03	1.053E 04	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY ROLL	2.744E 04	1.107E 02	4.947E 03	5.931E 03	0.0
CLIMB 1	3.237E 04	2.202E 02	1.550E 04	1.775E 04	0.0
CLIMB 2	9.066E 02	1.498E 02	1.414E 04	1.787E 04	0.0
APPROACH 1	1.993E 03	2.847E 02	2.377E 04	3.416E 04	0.0
APPROACH 2	1.924E 03	2.786E 02	2.283E 04	3.282E 04	0.0
LANDING	2.766E 01	1.450E 01	1.627E 00	9.582E 00	0.0
TAXI IN	9.103E 04	4.772E 04	5.355E 03	3.153E 04	0.0
SHUTDOWN	6.171E 04	3.235E 04	3.630E 03	2.138E 04	0.0
ARR + DEP SV	1.149E 01	1.215E 00	5.267E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	9.005E 00	0.0	0.0	0.0
BREAK ENTRY	6.413E 02	9.162E 01	7.650E 03	1.099E 04	0.0
BREAK TURN	2.641E 02	3.773E 01	3.150E 03	4.528E 03	0.0
DOWNWIND LEG	2.029E 03	2.899E 02	2.421E 04	3.479E 04	0.0
TOTAL	2.663E 05	1.056E 05	1.279E 05	2.277E 05	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

		VFR APPROACHES			
BREAK ENTRY	6.413E 02	9.162E 01	7.650E 03	1.099E 04	0.0
BREAK TURN	2.641E 02	3.773E 01	3.150E 03	4.528E 03	0.0
DOWNWIND LEG	7.878E 02	1.125E 02	9.397E 03	1.351E 04	0.0
APPROACH 1	5.242E 02	7.488E 01	6.253E 03	8.986E 03	0.0
APPROACH 2	5.081E 02	7.259E 01	6.061E 03	8.711E 03	0.0

		TOUCH AND GOS			
CLIMB 1	1.264E 02	2.528E 01	2.692E 03	2.996E 03	0.0
CLIMB 2	1.524E 02	2.178E 01	1.818E 03	2.613E 03	0.0
APPROACH 1	4.411E 02	6.301E 01	5.261E 03	7.561E 03	0.0
APPROACH 2	4.276E 02	6.108E 01	5.100E 03	7.329E 03	0.0
DOWNWIND LEG	5.798E 02	8.283E 01	6.916E 03	9.939E 03	0.0

		FCLPS			
CLIMB 1	3.313E 02	6.626E 01	7.057E 03	7.852E 03	0.0
CLIMB 2	3.990E 02	5.700E 01	4.760E 03	6.840E 03	0.0
APPROACH 1	1.005E 03	1.436E 02	1.199E 04	1.723E 04	0.0
APPROACH 2	9.759E 02	1.394E 02	1.164E 04	1.673E 04	0.0
DOWNWIND LEG	6.617E 02	9.452E 01	7.893E 03	1.134E 04	0.0

A-4

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	9.002E 02	7.335E 02	3.175E 01	0.0	0.0
TAXI OUT	2.143E 04	1.746E 04	7.560E 02	0.0	0.0
ENGINE CHECK	0.0	0.0	0.0	0.0	0.0
RUNWAY ROLL	9.708E 00	4.854E 01	1.107E 03	0.0	0.0
CLIMB 1	1.845E 01	9.223E 01	2.103E 03	0.0	0.0
CLIMB 2	1.358E 02	1.866E 02	3.965E 03	0.0	0.0
APPROACH 1	3.889E 02	2.122E 02	3.819E 03	0.0	0.0
APPROACH 2	3.743E 02	2.054E 02	3.630E 03	0.0	0.0
LANDING	1.304E 01	1.062E 01	4.599E-01	0.0	0.0
TAXI IN	6.055E 04	4.934E 04	2.136E 03	0.0	0.0
SHUTDOWN	1.542E 04	1.256E 04	5.439E 02	0.0	0.0
ARR + DEP SV	1.426E 01	1.520E 00	5.859E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	6.706E 00	0.0	0.0	0.0
BREAK ENTRY	2.740E 02	1.495E 02	2.690E 03	0.0	0.0
BREAK TURN	1.128E 02	6.155E 01	1.108E 03	0.0	0.0
DOWNWIND LEG	5.594E 02	3.051E 02	5.492E 03	0.0	0.0
TOTAL	1.002E 05	8.138E 04	2.738E 04	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER LANDING PRACTICE TO THIS SUMMARY

		VFR APPROACHES			
BREAK ENTRY	2.740E 02	1.495E 02	2.690E 03	0.0	0.0
BREAK TURN	1.128E 02	6.155E 01	1.108E 03	0.0	0.0
DOWNWIND LEG	3.179E 02	1.734E 02	3.121E 03	0.0	0.0
APPROACH 1	2.067E 02	1.127E 02	2.029E 03	0.0	0.0
APPROACH 2	2.003E 02	1.093E 02	1.967E 03	0.0	0.0
		TOUCH AND GOS			
CLIMB 1	6.814E 00	3.407E 01	7.768E 02	0.0	0.0
CLIMB 2	6.443E 01	3.514E 01	6.326E 02	0.0	0.0
APPROACH 1	6.637E 01	3.620E 01	6.516E 02	0.0	0.0
APPROACH 2	6.434E 01	3.509E 01	6.317E 02	0.0	0.0
DOWNWIND LEG	1.336E 02	7.285E 01	1.311E 03	0.0	0.0
		FCLPS			
CLIMB 1	4.881E 00	2.441E 01	5.565E 02	0.0	0.0
CLIMB 2	4.609E 01	2.514E 01	4.525E 02	0.0	0.0
APPROACH 1	1.072E 02	5.845E 01	1.052E 03	0.0	0.0
APPROACH 2	1.040E 02	5.674E 01	1.021E 03	0.0	0.0
DOWNWIND LEG	1.080E 02	5.889E 01	1.060E 03	0.0	0.0

F 5

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.877E 01	5.257E 00	6.633E-01	3.755E 00	1.252E-01
TAXI OUT	8.594E 00	2.406E 00	3.037E-01	1.719E 00	5.729E-02
ENGINE CHECK	2.908E 00	9.950E-02	3.368E-01	7.654E-01	7.654E-02
RUNWAY ROLL	3.531E 00	6.725E-03	5.044E-01	8.406E-01	1.681E-01
CLIMB 1	2.281E 00	1.891E-02	3.137E-01	5.545E-01	9.904E-02
CLIMB 2	2.411E 00	1.423E-01	2.540E-01	6.727E-01	5.920E-02
APPROACH 1	1.590E 00	2.576E-01	9.867E-02	5.482E-01	2.741E-02
APPROACH 2	1.900E 00	3.079E-01	1.179E-01	6.551E-01	3.276E-02
LANDING	0.0	0.0	0.0	0.0	0.0
TAXI IN	4.588E 01	1.285E 01	1.621E 00	9.176E 00	3.059E-01
SHUTDOWN	2.747E 00	7.691E-01	9.705E-02	5.493E-01	1.831E-02
ARR + DEP SV	4.031E 00	4.303E-01	1.627E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	1.010E 00	0.0	0.0	0.0
BREAK ENTRY	2.551E 00	4.134E-01	1.583E-01	8.796E-01	4.398E-02
BREAK TURN	1.050E 00	1.702E-01	6.520E-02	3.622E-01	1.811E-02
DOWNWIND LEG	2.211E 00	3.583E-01	1.372E-01	7.624E-01	3.812E-02
TOTAL	1.005E 02	2.449E 01	4.834E 00	2.124E 01	1.070E 00

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	2.551E 00	4.134E-01	1.583E-01	8.796E-01	4.398E-02
BREAK TURN	1.050E 00	1.702E-01	6.520E-02	3.622E-01	1.811E-02
DOWNWIND LEG	1.122E 00	1.819E-01	6.967E-02	3.870E-01	1.935E-02
APPROACH 1	8.461E-01	1.371E-01	5.252E-02	2.918E-01	1.459E-02
APPROACH 2	8.188E-01	1.327E-01	5.082E-02	2.823E-01	1.412E-02

TOUCH AND GOS

CLIMB 1	4.507E-01	1.542E-02	5.219E-02	1.186E-01	1.186E-02
CLIMB 2	4.679E-01	7.583E-02	2.904E-02	1.613E-01	8.067E-03
APPROACH 1	7.435E-01	1.205E-01	4.615E-02	2.564E-01	1.282E-02
APPROACH 2	1.081E 00	1.752E-01	6.711E-02	3.728E-01	1.864E-02
DOWNWIND LEG	1.089E 00	1.764E-01	6.756E-02	3.754E-01	1.877E-02

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

TRANSENT

OPERATION	CO	HC	NOX	PM	SOX
STARTUP	1.787E 04	1.456E 04	6.302E 02	0.0	0.0
TAXI OUT	7.173E 03	5.845E 03	2.530E 02	0.0	0.0
ENGINE CHECK	3.655E 01	1.828E 02	4.167E 03	0.0	0.0
RUNWAY ROLL	1.155E 01	5.773E 01	1.316E 03	0.0	0.0
CLIMB 1	9.210E 00	4.605E 01	1.050E 03	0.0	0.0
CLIMB 2	1.715E 01	8.576E 01	1.955E 03	0.0	0.0
APPROACH 1	8.060E 02	4.407E 02	7.933E 03	0.0	0.0
APPROACH 2	9.310E 02	7.114E 02	1.747E 03	0.0	0.0
LANDING	3.772E 03	3.073E 03	1.330E 02	0.0	0.0
TAXI IN	1.369E 04	1.115E 04	4.828E 02	0.0	0.0
SHUTDOWN	1.117E 03	9.099E 02	3.939E 01	0.0	0.0
ARR + DEP SV	7.178E 00	7.594E-01	3.261E-01	0.0	0.0
FUEL VENTING	0.0	0.0	0.0	0.0	0.0
FILL + SPILL	0.0	4.359E 00	0.0	0.0	0.0
BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
TOTAL	4.544E 04	3.707E 04	1.971E 04	0.0	0.0

CONTRIBUTUON OF VFR APPROACHES, TOUCH AND GO AND FIELD CARRIER

LANDING PRACTICE TO THIS SUMMARY

VFR APPROACHES

BREAK ENTRY	0.0	0.0	0.0	0.0	0.0
BREAK TURN	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0

TOUCH AND GOS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

FCLPS

CLIMB 1	0.0	0.0	0.0	0.0	0.0
CLIMB 2	0.0	0.0	0.0	0.0	0.0
APPROACH 1	0.0	0.0	0.0	0.0	0.0
APPROACH 2	0.0	0.0	0.0	0.0	0.0
DOWNWIND LEG	0.0	0.0	0.0	0.0	0.0

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